HYTAFILL AUTOMATIC INSPECTION UNIT
(Type 2)

Installation. . Operation. . Maintenance

Direction 12216

X-RAY DEPARTMENT
GENERAL ELECTRIC

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GENERAL ELECTRIC

Code 1-1057

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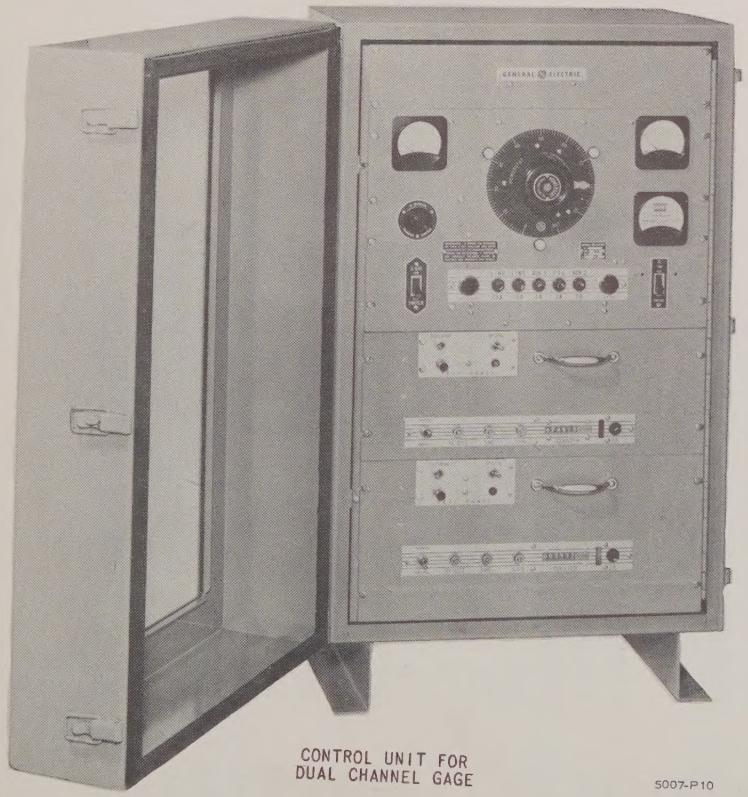
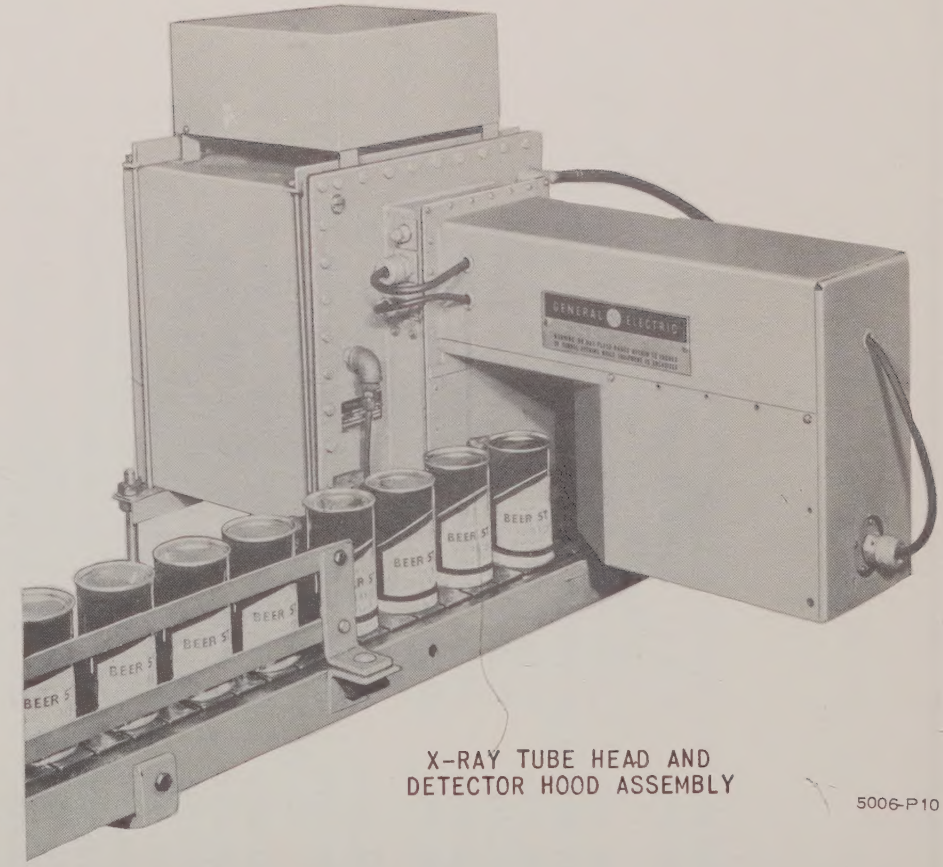


CONTROL UNIT FOR
DUAL CHANNEL GAGE

5007-P10



X-RAY TUBE HEAD AND
DETECTOR HOOD ASSEMBLY

5006-P10

HYTAFILL AUTOMATIC X-RAY UNITS
TYPE 2

A4012F	HYTAFILL, MODEL SC, Single Channel Gage - 115v, 60 cy, single phase, fused for 15 amperes
A4012G	HYTAFILL, MODEL TC, Dual Channel Gage - 115v, 60 cy, single phase, fused for 15 amperes. (Consists of Model SC plus A4012H.)
A4012H	CONVERSION KIT to convert single channel gage to dual channel gage.
A8061A A8061B	FLEXIBLE INTERCONNECTING CABLES (for operation of control within 50 ft. or 15 ft. of cable run of the inspection head). A8061A, 50 ft; A8061B, 15 ft.
D0032C	X-RAY TUBE SPI-100.
507A815G1	CADMIUM SELENIDE CRYSTAL, x-ray detector for single channel gage.
1003819G1	CADMIUM SELENIDE CRYSTALS, x-ray detector, for dual channel gage.

IMPORTANT . . . X-RAY PROTECTION

X-Ray equipment if not properly used, may cause injury. Accordingly, the instructions herein contained should be thoroughly read and understood before you attempt to place this equipment in operation. The General Electric Company, X-Ray Department will be glad to assist and cooperate in placing this equipment in use.

Although this apparatus incorporates a high degree of protection against x-radiation other than the useful beam, no practical design of equipment can provide complete protection. Nor can any practical design compel the operator or his assistant to take adequate precautions or prevent the possibility of authorized or unauthorized persons carelessly, unwisely, or unknowingly exposing themselves or others to direct or secondary radiation.

It is important that everyone having anything to do with x-radiation be fully acquainted with the recommendations of the National Committee on Radiation Protection as published in the National Bureau of Standards Handbooks, of the American Standards Association, and of the International Commission on Radiation Protection, and take adequate steps to insure protection.

It is assumed that all persons authorized to use the equipment are cognizant of the danger of excessive exposure to x-radiation and the equipment is sold with the understanding that the General Electric Company, X-Ray Department, its agents, and representatives have no responsibility for injury or damage which may result from exposure to x-radiation.

Various protective material and devices are available. It is urged that such materials or devices be used.

CAUTION

Only properly trained and qualified personnel should be permitted access to the internal parts. Be sure the line disconnect switch is opened before opening access doors or removing enclosure panels.

GENERAL ELECTRIC COMPANY X-RAY INDUSTRIAL APPARATUS WARRANTY

General Electric Company warrants that new Industrial x-ray apparatus sold by it to the Purchaser shall be free from defects in material or workmanship for a period of twelve months from the date of shipment, and no other warranties, except of title, shall be implied. New x-ray tubes and kenotrons, if any, incorporated in or supplied with said apparatus are not warranted hereunder but are covered by the Company's standard tube and kenotron warranty applicable thereto in effect on the date of sale. No warranties either expressed or implied shall apply to glassware or batteries.

If any defect in material or workmanship appears in new apparatus within the period of time specified above, the Purchaser shall notify the Company immediately and the Company shall thereupon correct the defect by repairing the defective part or by supplying a replacement therefor at the Company's expense, f.o.b. Factory uninstalled. The conditions of any test shall be mutually agreed upon and the Company shall be notified of, and may be represented at, all tests that may be made. The liability of the Company, except as to title, arising out of the supplying of said apparatus, or its use, whether on warranties or otherwise, shall be limited to the correction of defects as aforesaid, and upon the expiration of said warranty period all such liability shall terminate. In no event shall the Company be liable for consequential or special damages. The foregoing shall constitute the sole remedy of the Purchaser.

GENERAL ELECTRIC X-RAY SERVICE AVAILABLE

General Electric Company, X-Ray Department, and its associates maintain a world-wide organization of stations from which the assistance of skilled technicians, especially trained in x-ray problems may be obtained. You are invited to consult with the nearest General Electric Company, X-Ray Department, representative whenever problems arise.

If desired, arrangements can usually be made to furnish regular routine service calculated to minimize the possibility of mechanical or electrical failures with resultant interruptions in service. Our representative will be glad to discuss this plan with you.

GENERAL ELECTRIC HYTAFILL AUTOMATIC INSPECTION UNIT
(Type 2)

Installation. . Operation. . Maintenance

Direction 12216

1.00 GENERAL

1.01 The Hytafill is an automatic x-ray inspection device for monitoring the height-of-fill of materials in sealed containers. Without any physical contact with the containers, the unit singles out unacceptable products and provides a means to actuate the reject mechanism (supplied by the customer) that separates the unacceptable products from the acceptable ones. For maximum usefulness, the Hytafill has been designed to inspect a variety of types of containers and fill materials.

1.02 Relatively soft and low intensity x-radiation is used to penetrate the opaque containers. The x-radiation is collimated into a 5/16" x 3/32" (at tube head) rectangular beam whose center traverses the container just below the desired level of inspection.

1.03 Maximum inspection speeds of 900 containers per minute and inspection accuracies of a few grams are obtainable because minute cadmium selenide crystals are used as the x-ray detector device. Cadmium selenide crystals are effective as detector devices because the electrical conductivity of the crystals changes rapidly and significantly for small changes in impinging pulsed x-ray intensities. The match-head physical size of the crystals inherently provides the Hytafill with superior level inspection accuracy.

1.04 The single channel Hytafill gage, Model SC, will single out either under or overfilled containers. For singling out both under and overfilled containers, the dual channel unit, Model TC, is supplied. These instructions will cover the installation and initial adjustments for both the dual and the single channel gages.

1.05 Both the single and dual channel gages include an x-ray tube head, an x-ray detector assembly, and a control unit.

2.00 COMPONENT DESCRIPTION

2.01 The CONTROL UNIT consists of three component panels mounted on a hinged frame within the control housing. The front section of the housing is also hinged and contains a large window so that the controls and indicators may be readily observed. So that the

unit may be periodically washed with a spray of water or steam the front and rear sections of the housing are sealed with a heavy gasket with three trunk-type latches providing the sealing pressure.

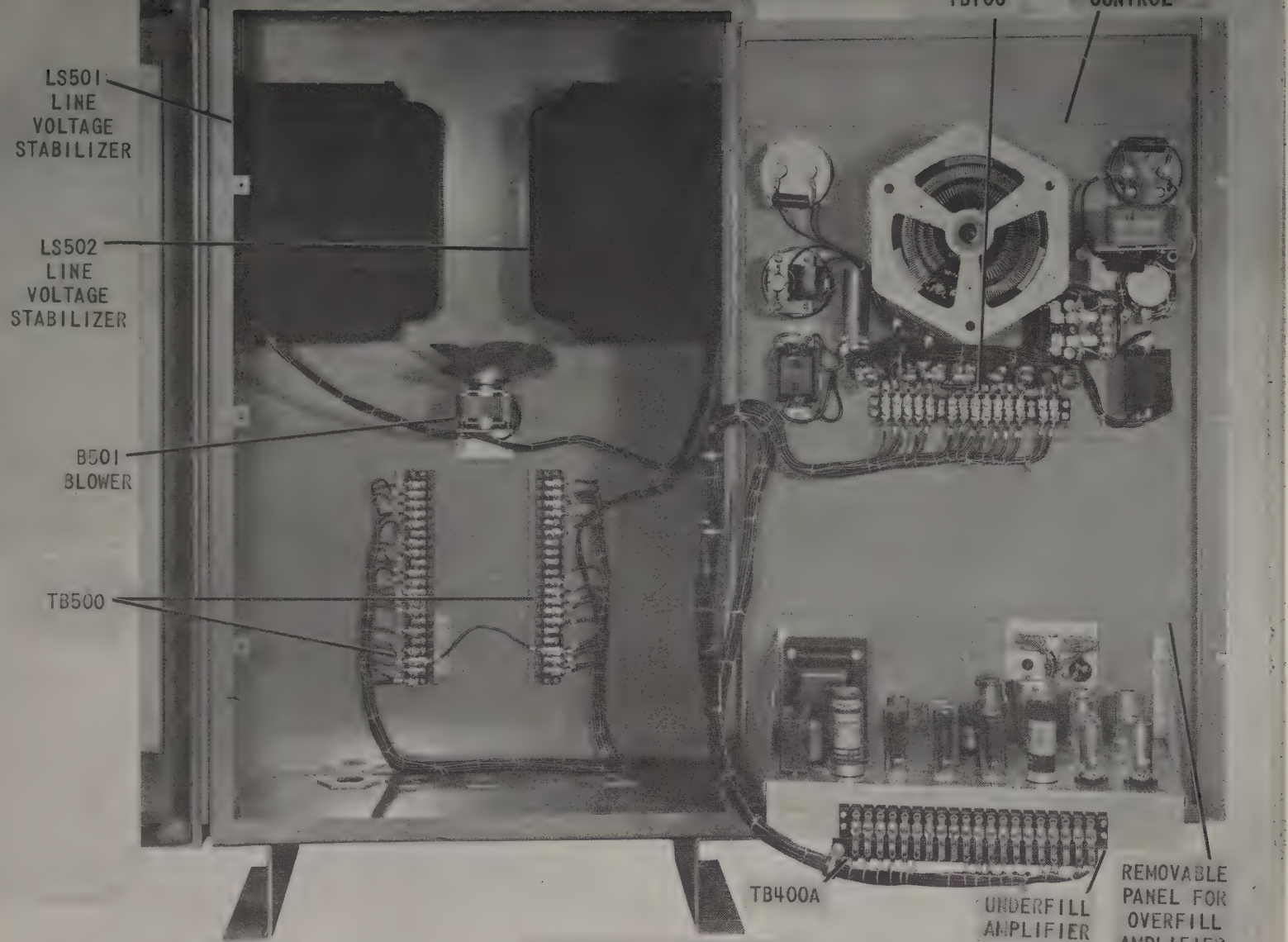
2.02 The hinged arrangement of both the housing and control panel allows for easy access to the circuits for adjustment and servicing.

2.03 The control housing is 38" high, 22" wide, 18" deep and weighs approximately 250 pounds.

2.04 Mounted on the upper-center panel is the x-ray generator control. This control chassis contains the Line and X-Ray ON-OFF switch, a primary volt reading meter for the high voltage transformer; a variac for adjustment of the voltage applied to the high voltage primary; a d-c milliammeter to read the x-ray tube current; a filament control rheostat, for adjustment of x-ray tube current through a range of 1.5 to 5 ma; a filament current stabilizing relay; and an hour meter to indicate the total running time of the Hytafill unit. A green light, Ready, on the panel indicates that the Hytafill is ready for duty. A red light, Stand-By, indicates that the unit is not ready for duty. If there is no malfunctioning in the electronic power supplies or tube head, the red light will stay on and the green light will come on after the warm-up time delay period of 30 seconds is completed.

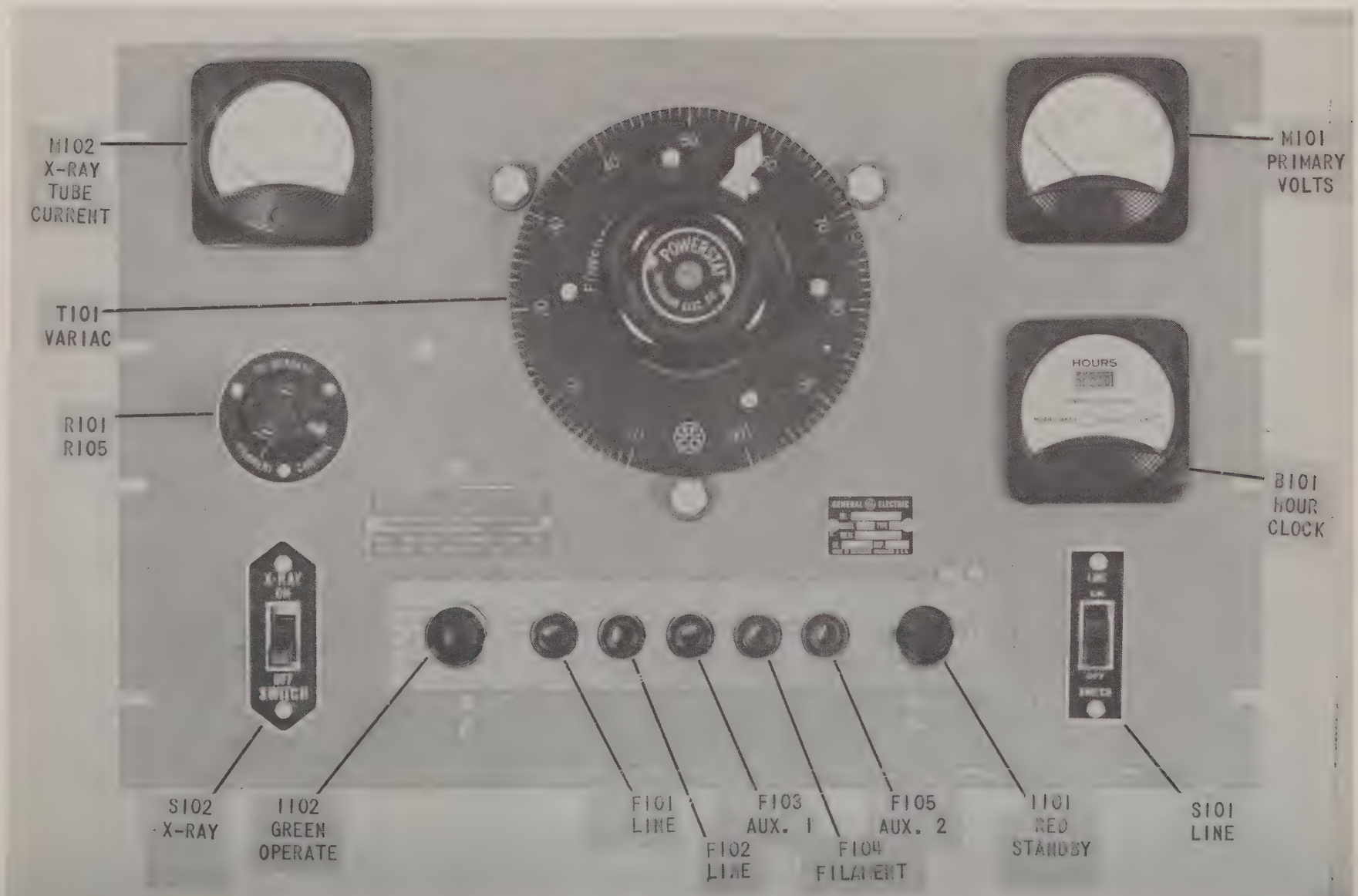
2.05 The lower-center and bottom panels mount identical detector signal amplifier and relay chassis. For Model TC, the dual channel gage unit, two identical chassis are supplied. For Model SC, the single channel gage unit, only one electronic chassis is supplied. The electronic chassis contains the circuits for amplifying the crystal detector signals, circuits for limiting the acceptance of the crystal signals to only those time intervals that a container is in the inspection position, a single cycle type multivibrator circuit which develops a reject signal when triggered by the crystal detector signals of the proper magnitude, a reject relay with contacts to energize the reject mechanism furnished by the customer, the necessary regulated power supplies and amplifier controls, and a test panel to aid in isolating and locating trouble within the unit. Each electronic chassis also contains an Over-Under fill switch that determines which condition of faulty fill each chassis will monitor and a counter to indicate the number of rejected containers. The counter may be manually reset to zero when desired.

2.06 Mounted on the back of the control housing are two 500 VA stabilizers, connected in parallel, to provide a stable input to the Hytafill circuits. A fan is provided to prevent localized heating of the components.



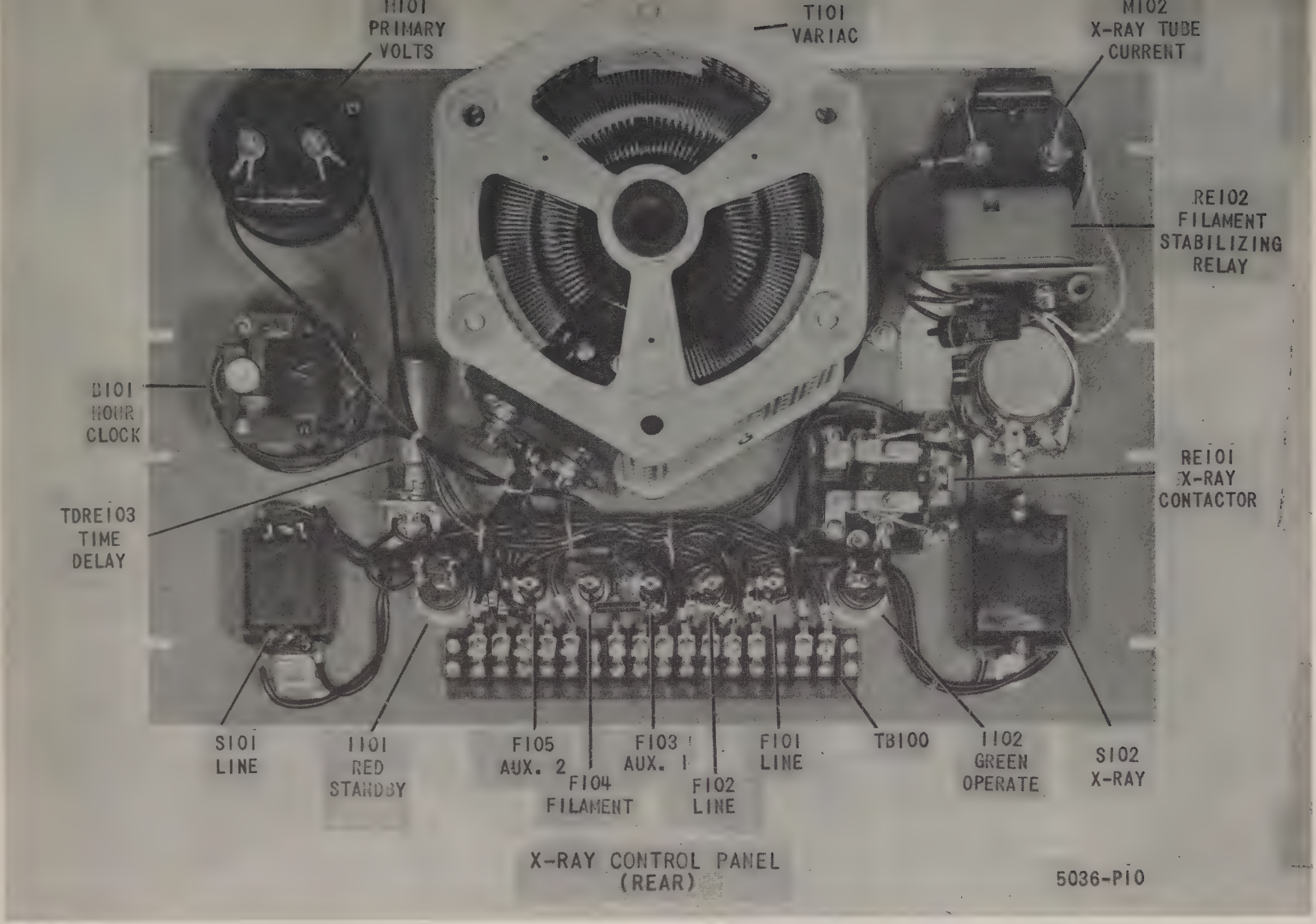
CONTROL UNIT WITH
CONTROL DOOR OPEN

5034-P10



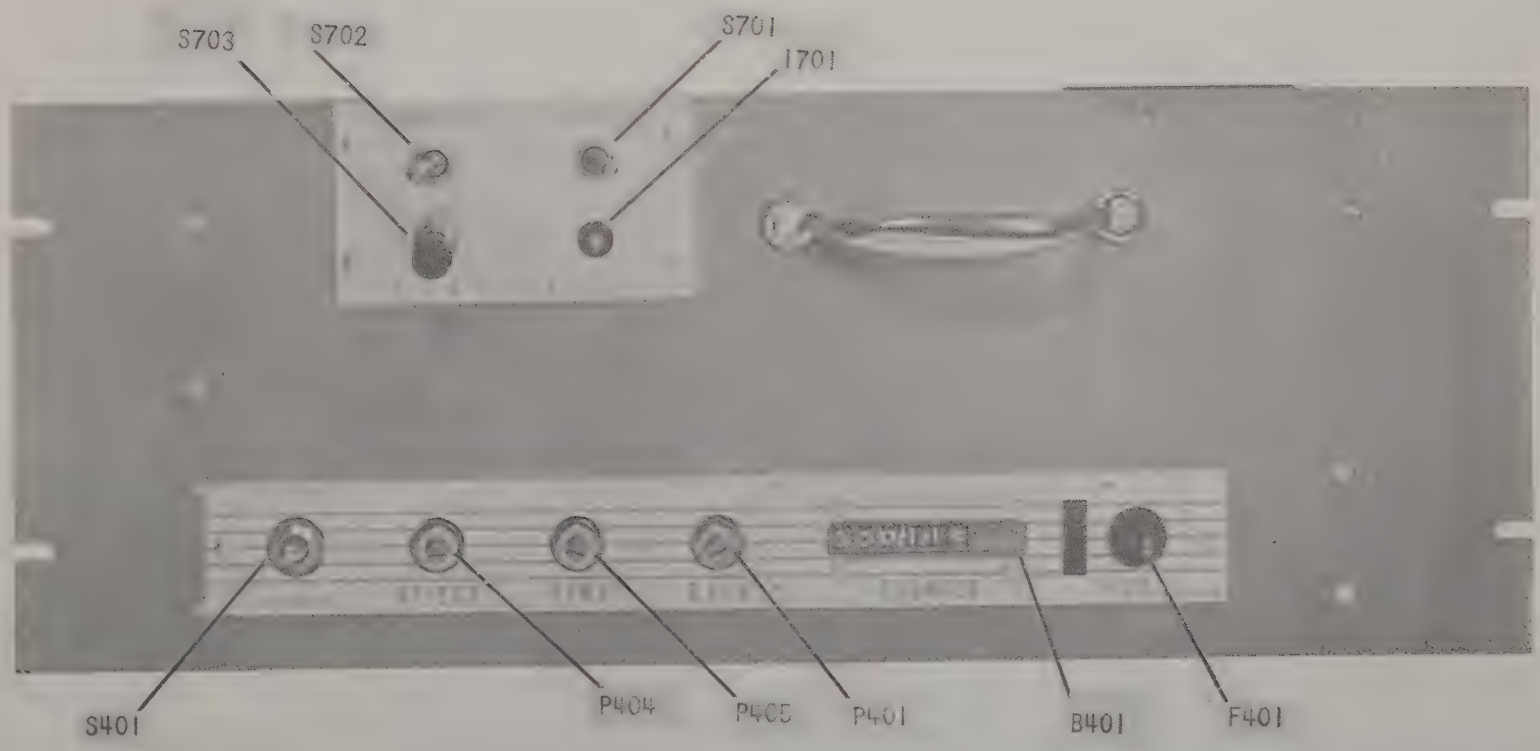
X-RAY CONTROL PANEL
(FRONT)

5035-P10



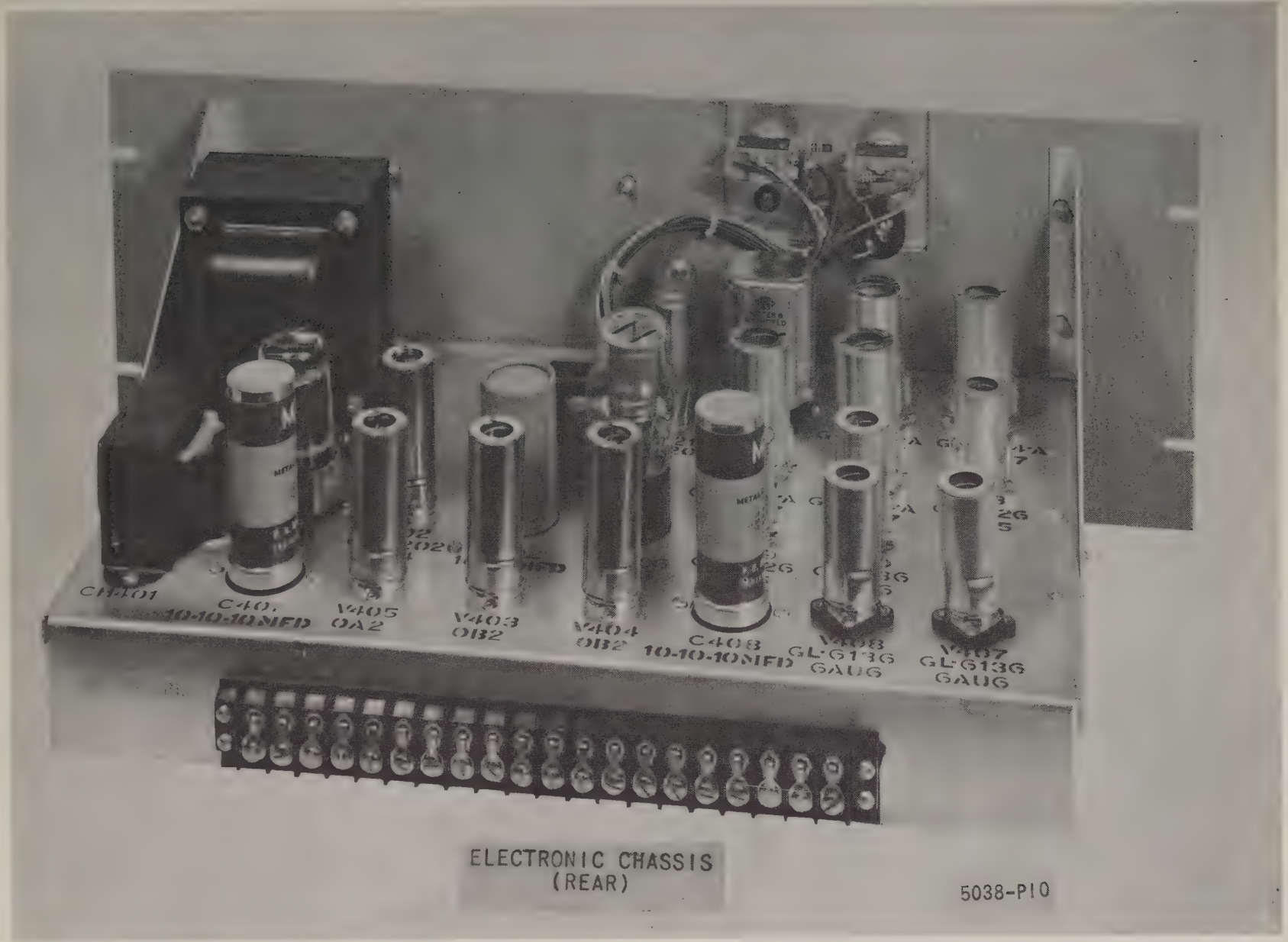
X-RAY CONTROL PANEL
(REAR)

5036-P10



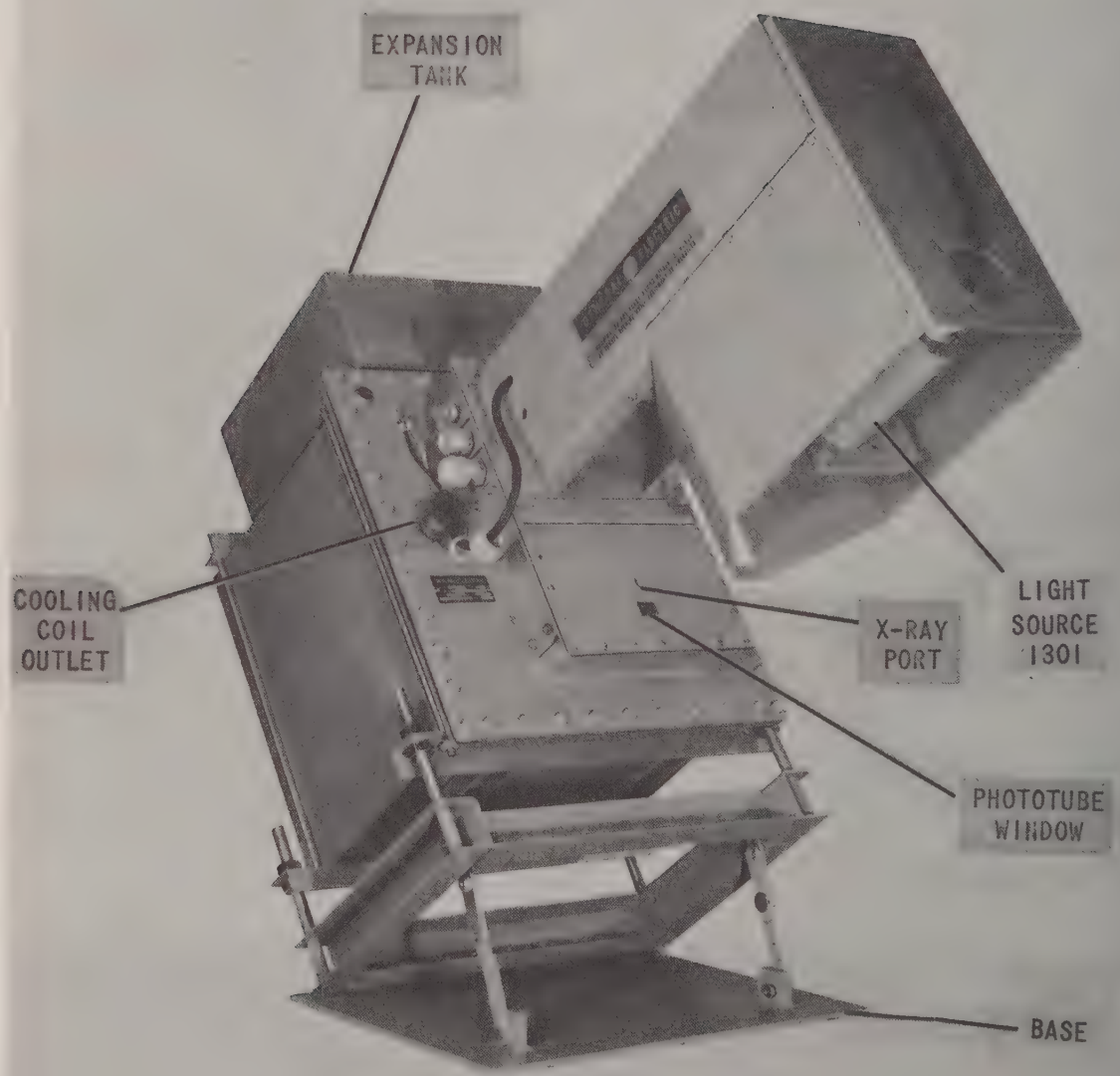
ELECTRONIC CHASSIS
(FRONT)

5037-P10



ELECTRONIC CHASSIS
(REAR)

5038-P10



X-RAY TUBE HEAD AND DETECTOR HOOD ASSEMBLY (TILTED ON HINGED BASE)

5033-P10

2.07 The Control Unit may be mounted anywhere within fifty feet of cable run from the x-ray beam generator and detector assembly. The component parts are equipped with fittings that permit the use of either flexible cable or conduit for the interconnecting wiring. If the customer elects to use conduit, he is responsible for the conduit installation.

2.08 The X-RAY TUBE HEAD contains the components necessary for the generation of the x-radiation required for the inspection process. These components consist of the high-voltage and filament transformers, and the SPI-100 x-ray tube. The tube head is filled with No. 917 insulating oil and is designed for continuous operation at a maximum rating of 100 kilovolts peak (KVP) and a tube current rating of 5 milliamperes (MA). A primary voltmeter reading of 110 volts produces approximately 100 KVP across the x-ray tube.

2.09 In addition to the components listed above an over-temperature switch and water cooling coils are also included in the tube head to insure safe operation. The cooling coils are terminated in 3/8" tapered pipe thread compression fittings on the front of the tube head to permit connection to a tap water supply or closed water cooler system, in the event water cooling is required. Operating conditions for which additional cooling is required are listed under INSTALLATION REQUIREMENTS, Section 3.03.

2.10 The tube head tank is mounted on a base assembly which has adjustment screws for leveling and height adjustments over a range of three inches. Provision is also made to allow the tube head and detector housing to be tilted approximately 40 degrees with respect to the conveyor. By this means, all tests and adjustments, except x-ray beam level adjustment, may be made while the conveyor is in operation.

2.11 A hermetically sealed oil expansion tank is mounted on top of the tube head to allow the volume of oil in the tube head to vary with temperature without endangering the high-voltage components. An oil hose connects the expansion tank to the tube head.

2.12 The X-RAY DETECTOR ASSEMBLY includes a cadmium selenide crystal, type X-4, contained in a moisture and light-proof housing that is mounted on a crossarm from the x-ray tube head. The crystal mounting assembly provides for spacing adjustments to accommodate various conveyor widths and various container widths and heights. For the dual channel gage unit, two crystals are mounted in the sealed housing. The crystal unit is enclosed within an x-ray protective hood that includes the light source which is used to signal the fact that a container is in the inspection position.

2.13 Mounted on the front of the tube head within a steel enclosure is an electronic chassis, which includes the gating signal phototube stage, two crystal signal cathode followers, and an x-ray port shutter mechanism with its actuating relays. An access panel is located on the side of the steel enclosure to allow for replacement of the electronic tubes. Also accessible through the opening are three test terminals for measurements of gating potentials and each of the crystal signal voltages.

2.14 The front cover of the cathode follower housing is split into two sections to permit replacing or aligning the phototube without removing the detector hood assembly and disturbing the crystal alignment.

3.00 INSTALLATION REQUIREMENTS

3.01 The LINE VOLTAGE, including fluctuations, may be from 95 to 130 volts, 60 cycles, single phase. Two 500 VA stabilizers are mounted in the control housing and connected in parallel to provide a stable input voltage to the Hytafill circuits.

3.02 Supporting Stands

a. At the desired point of inspection, a rigid, vibration free platform must be provided, capable of supporting the 250 pound tube head and detector assembly. A recommended stand is shown on Drawing 4935-D10. The height of the platform must be such that the x-ray port in the tube head is within one inch of the desired level of the fill material to be inspected. Refer to Drawing 3548-D44 for the tube head dimensions. The height of the base supplied with the tube head is adjustable over a three inch range. Allow sufficient room between tube head and conveyor to accommodate reject mechanism.

b. The control housing may be mounted anywhere within 50 feet of cable run from the point of inspection. Refer to Drawing 4801-D20 for dimensional requirements and Drawing 4935-D10 for a recommended stand. Allow access to front of unit with control window and door open.

3.03 WATER COOLING for the x-ray tube head is required when the product of the operating primary volts and the ma exceed the values given in the following chart at given ambient temperatures.

Ambient Temperature	Product of Operating Primary Volts Times MA
110° F	72
100° F	100
90° F	167
80° F	310
70° F	390

COMPONENT MOUNTING STAND
FOR GENERAL ELECTRIC HYTAFILL TYPE 2

Tools Required:

Welding and cutting torch.
3/8 inch drill.

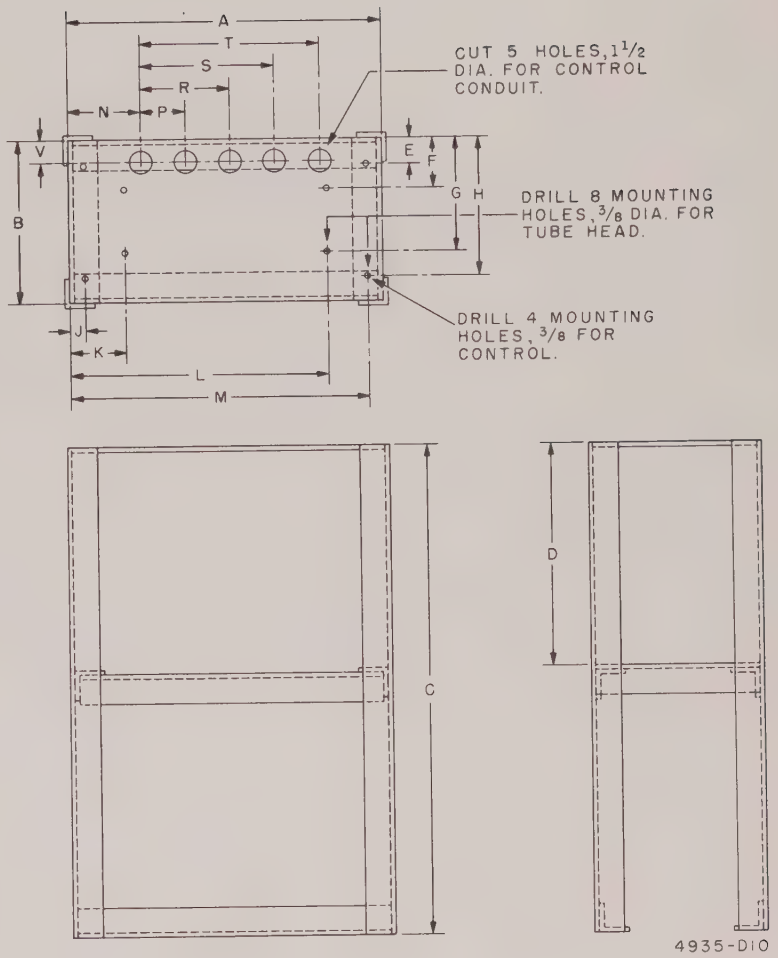
Material:

Top plate -- 5/16" Steel Plate
Legs, center braces, and bottom braces: 2"x2" angle iron.

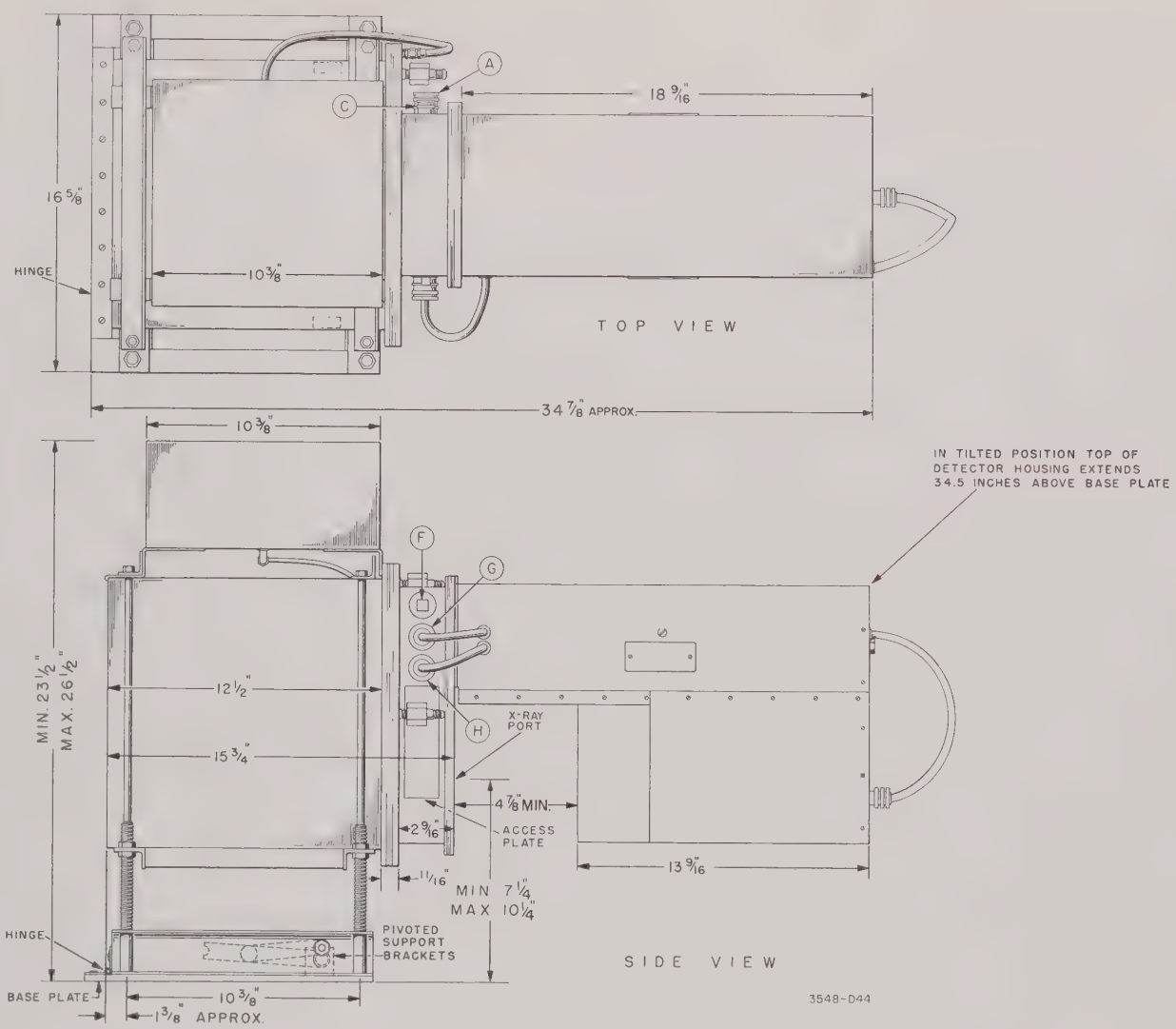
Method:

Weld all joints.
Cut rear brace on control stand for conduit, if required.
Drill two bottom braces to provide anchor to floor.

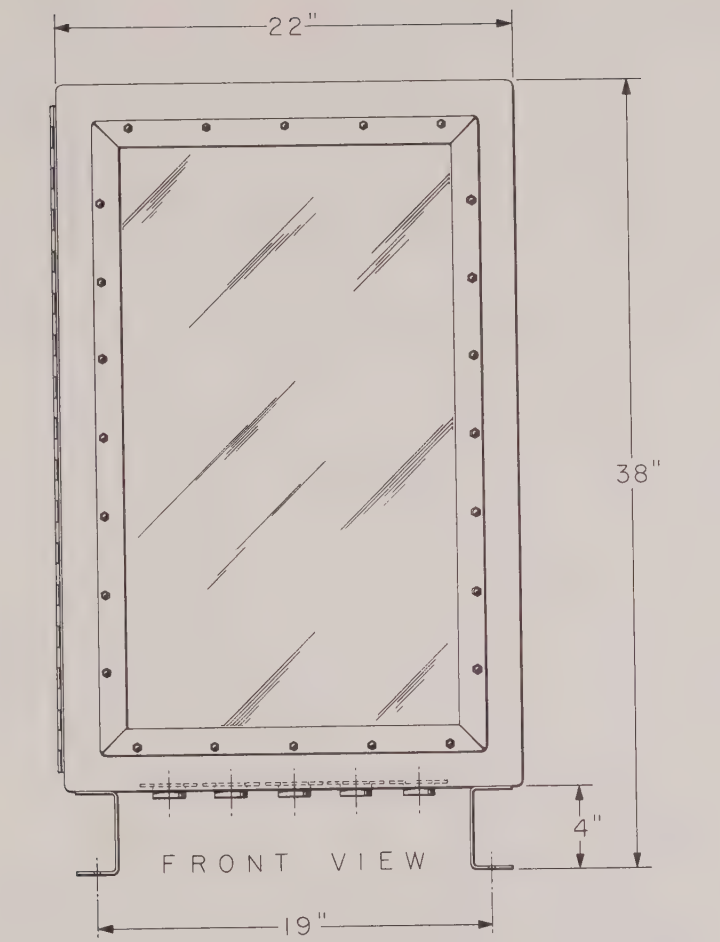
Dimension	Control	Tube Head
A	21	16-5/8
B	11	13
C	30	X*
D	15	1/2X*
E	1-3/4	2
F	--	3-3/8
G	--	11
H	9-1/4	12-3/8
J	1	2-5/16
K	--	3-13/16
L	--	12-13/16
M	20	14-5/16
N	4-15/16	--
P	3	--
R	6	--
S	9	--
T	12	--
V	1-1/2	--



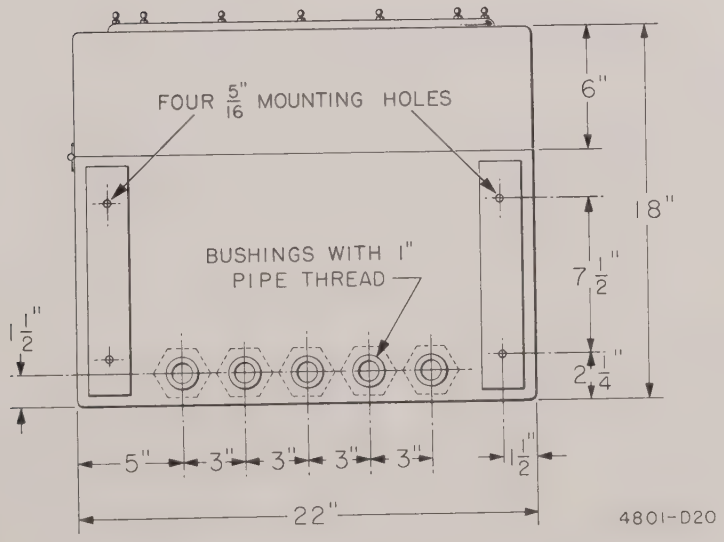
*X Dimension equals distance from floor to desired fill line on can minus 8-3/4 inches.



TUBE HEAD AND DETECTOR ASSEMBLY



FRONT VIEW



BOTTOM VIEW

TABLE I

WIRING DATA FOR HYTAFILL UNIT

Refers to Cable or Conduit Port Designations on Drawing 3548-D44

Conduit A	1" conduit for head cable	20 conductors of #16 wire.
Conduit B	3/4" conduit for line cable	3 conductors of #14 wire.
Conduit C	1/2" conduit for signal cable	2 conductor shielded, or 3 conductor shielded cable (furnished by G-E)
Conduit D	1/2" conduit for reject cable	2 to 6 conductors, size and number of wires dependent upon reject system that will be used.
Conduit E	3/8" conduit for remote counters or indicators. (This is for any external indicators that may be desired).	
Conduit F	3/8" conduit for extra cable	(Spare for any additional equipment.)
Cable G	3/8" port for light cable	2 conductors (furnished by G-E).
Cable H	3/8" port for crystal cable	2 conductor shielded cable or 3 conductor shielded cable (furnished by G-E).

TABLE II

CONDUIT WIRING INFORMATION FOR HYTAFILL

Wiring for Conduit Interconnection Between
X-Ray Tube Head and Control Unit
(Based on 50 Foot Conduit Runs)

Mark One End (control)	Mark Other End (tube head)	Wire Size AWG
10	GND	#14 RW
13	3	#18 RW
14	1	#18 RW
15	4	#18 RW
16	2	#18 RW
17	7	#18 RW
18	8	#14 RW
19	9	#14 RW
20	10	#18 RW
21	MA	#18 RW
22	P2	#14 RW
23	P1	#14 RW
24	K	#18 RW
26	F2	#18 RW

Use 1" rigid conduit, with explosion proof connections. Pull 9 #18 AWG and 6 #14 AWG wires (includes one spare #14 to be used to pull signal cable through conduit).

Terminate the rigid conduit to the tube head in a water proof junction box mounted on or near the tube head mounting platform. Use a cable such as G.E. X-Ray Cat. #A8061A, S1-58274, 20 conductor cable to complete the interconnection to the tube head. This will allow for positioning the tube head during installation adjustments. It may also be advisable to terminate the rigid conduit in a junction box mounted near the control unit. When using the A8061B cable, connect one #16 cable conductor to each #18 wire in the conduit, and connect two #16 cable conductors to each #14 wire in the conduit.

Wiring for 115 Volts, 15 Amperes Line Voltage Supply

Use three #12 AWG wires RW (one #12 for Hytafill external ground, connected to TB500-9) from the line voltage supply.

Tap water may be used if it is available, or a closed water cooler system may be used.

3.04 When operating conditions are such that the need for water cooling as determined from the above chart is not definitely established, the unit may be operated for a period of time to determine if the tube head will become overheated. A thermal switch located in the top section of the tube head will open the high voltage transformer primary circuit when the temperature of the oil around the switch is approximately 145°F.

3.05 If tap water cooling is necessary, an adjustable valve should be installed in the inlet line. It is recommended that the valve be adjusted to limit the water flow so that, after the tube head temperature reaches the point at which the heat dissipated is equal to the heat generated, the tank is noticeably warm to the palm of the hand when the hand is placed on the upper surface of the tube head. This precaution is essential when the tap water is near freezing temperatures.

3.06 A solenoid valve, 115 v a-c should also be installed in the inlet water line. The solenoid coil should be energized by the Hytafill Line ON-OFF switch. The coil may be connected across TB500-28 and TB500-29 in the control. If low temperature water is allowed to flow through the tube head when the Hytafill is shut down, the tube head temperature may become excessively low. Then, when the Hytafill is turned on, the instantaneous heat generated inside the x-ray tube may permanently damage the x-ray tube.

3.07 A flexible, INTERCONNECTING CABLE, in lengths of 15 ft. or 50 ft., for connecting the control unit and x-ray beam generator and detector may be purchased from the General Electric Company, X-Ray Department. A line cable, 15 ft. long, is supplied with the interconnecting cable to connect the control to the line supply.

3.08 If the customer desires or local regulations demand conduit, the customer must supply the necessary conduit, fittings, and wiring. Conduit and wiring details are shown in Tables I and II. The openings in the Hytafill control are fitted to accept rigid conduit and fittings.

3.09 The phototube light source cable, crystal cable and signal cable are normally supplied with the Hytafill.

3.10 The REJECT SYSTEM should be decided upon and be available at the time of installation so an overall operation check can be made.

Any workable system desired by the customer may be used. Reject relay contacts rated at 110 volts a-c, 5 amperes, are provided to energize the selected reject mechanism.

3.11 One method of physically rejecting the containers that has been successfully used employs a solenoid operated air valve and an air jet to "blow" containers from the line. A suitable valve for this purpose may be obtained from the following manufacturers:

a. Beckett - Harcum Company
Wilmington, Ohio
Piloted Model B-1 Solenoid Control Air Valve
(For line speeds up to 900 containers per minute.)

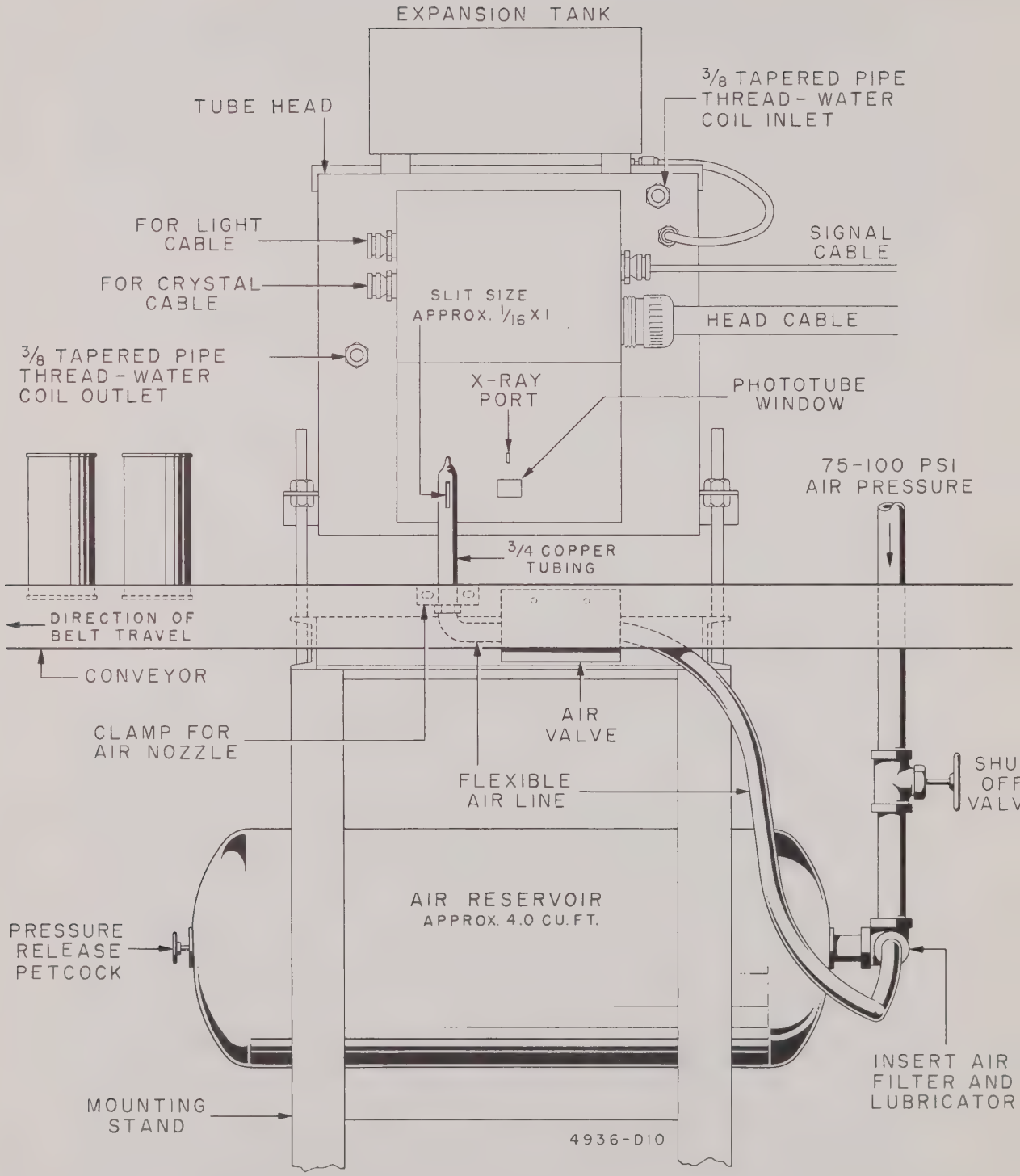
b. Valvair Corporation
Akron, Ohio
Model 1763 Solenoid Operated Valve with Over-ride
(For line speeds up to 600 containers per minute.)

For containers of approximate weights of beer, condensed milk, and frozen fruit juice cans (10-16 oz.), a 3/4 inch valve is recommended. A one inch valve is recommended for containers with gross weights equivalent to one quart size oil cans. Size, weight and speed of containers will determine the volume and pressure of air required for positive rejection.

3.12 A 75-100 lbs. per square inch air line is recommended. A reservoir tank approximately 8 inches in diameter and thirty inches long should be installed close to the valve. A shut-off valve should be placed before the surge tank, and a drain pet-cock should be placed at the bottom of the tank. Between the reservoir tank and the air valve, installation of an air line lubricator and an air filter is required to ensure trouble-free operation of the air valve.

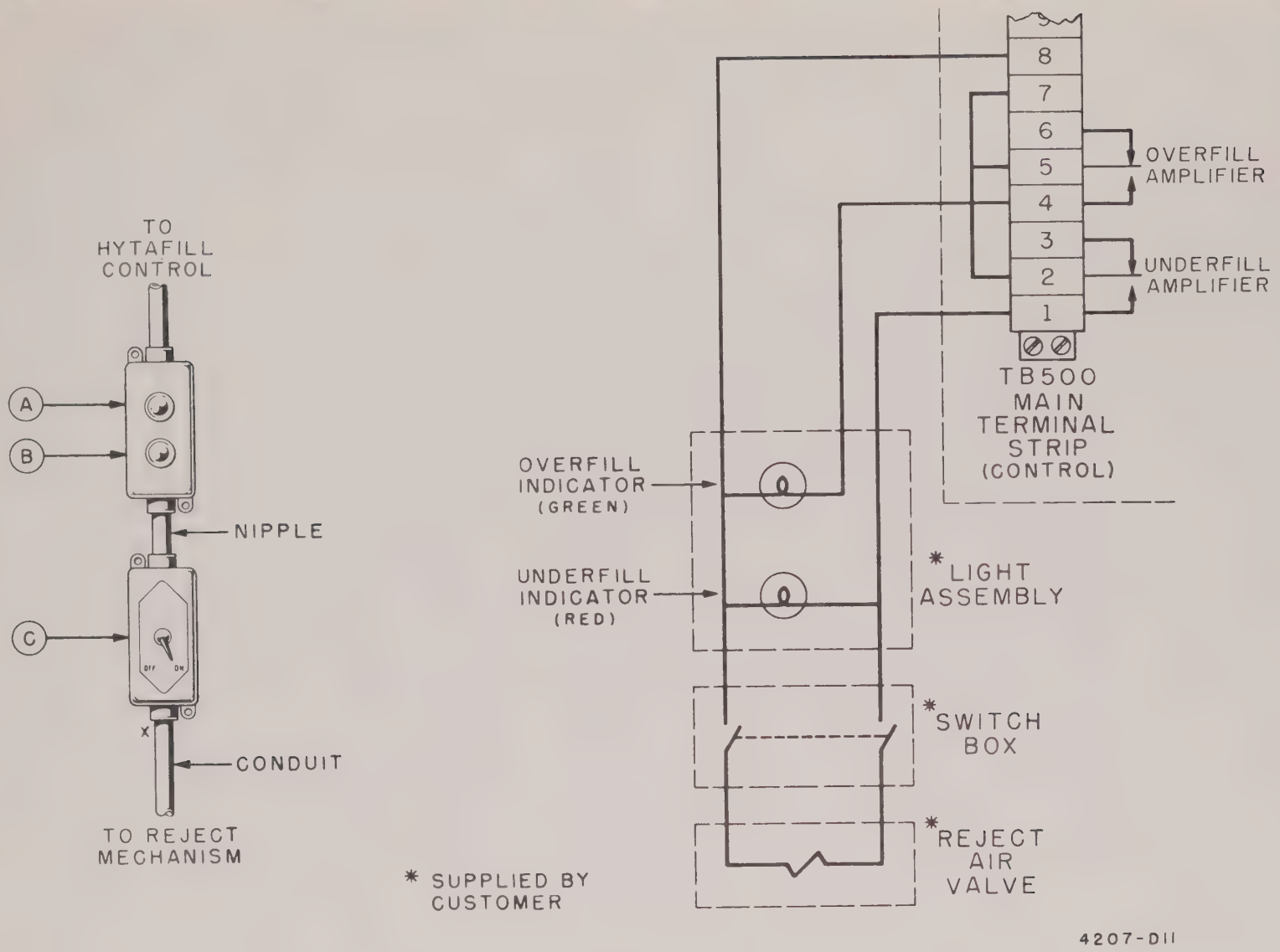
3.13 One satisfactory shape for the air jet is a narrow slit in a piece of tubing or pipe. For medium sized cans, the air jet slit is approximately 1/16" wide, and 1 inch to 1-1/2" long, and the longer slit dimension should be perpendicular to the conveyor belt. The actual positioning of the jet is determined experimentally upon installation; the jet position, however, will be close to the center of the tube head and set to blow the containers at an angle. (See Drawing 4936-D10, "Air Blast Reject System".)

3.14 Since the reject action supplied by the Hytafill Unit occurs just as the container moves out of the inspection position and while the container is still within the protective detector housing, most mechanical type reject mechanisms will require that a space delay device



HYTAFILL

AIR BLAST REJECT SYSTEM



AUXILIARY INDICATING LIGHT CIRCUIT
HYTAFILL TYPE 2

be incorporated in the reject mechanism.

3.15 A reject chute is normally desirable. This chute will be located on the opposite side of the conveyor from the air jet. Care must be taken in the design of the chute to prevent it from deflecting or reflecting the air blast so that rejected containers will not be blown back on the line. A mesh screen placed in the portion of the chute that is in the path of the air blast may help solve this problem should it occur. The chute should be covered to prevent completely empty containers from becoming dangerous missiles.

3.16 AUXILIARY INDICATING LIGHTS, although not necessary for proper operation, are recommended to provide a visual indication each time a reject action is initialed by the Hytafill. The light across the Reject Air Valve, as shown on Drawing 4207-D11, will also serve as a check on the proper operation of the air valve or other reject mechanism.

3.17 During testing, the air valve switch, if used, can be opened allowing observation of reject action without actually blasting containers off the line. This method will allow test cans to be used without danger of having them dented by falling into a basket or other receptacle.

3.18 Any suitable arrangement will be satisfactory. However, to maintain watertight conditions the recommended components are listed. The component listing includes both the single and dual light assemblies should it be desired to monitor both over and underfill chassis.

3.19 Recommended Components: (refer to Drawing 4207-D11)

a. Crouse Hinds Co. EFSC 1524-J1
Pilot Light Condulet (Red Light)

b. Crouse Hinds Co. EFSC 1561-J1-J3
Pilot Light Condulet (Red and Green Light)

c. Crouse Hinds Co. EFSC 11001
Mark ON-OFF Condulet with Switch

NOTE: If rubber covered cable is used in place of conduit, Crouse Hinds Watertight Connectors as listed below must be used at points marked "X".

CGB 193 - for cable diameter of .250" to .375"

CGB 194 - for cable diameter of .375" to .500"

3.20 The FILL MATERIAL may be any fluid or material that will seek its own level and provide a well defined fill level. Irregularities in the fill level will tend to reduce the accuracy of inspection.

3.21 For wall materials of containers equivalent to 0.015 inches of commercial tin plate, fill materials must have a minimum specific gravity of 0.7. With lower x-ray absorption walls for the containers the minimum density of fill material may be proportionately less than 0.7.

3.22 CONTAINERS, when used with low density fill materials, may not have a wall material in which the x-ray absorption exceeds that which is obtained for 0.015 inches of commercial tin plate, or a total wall thickness of 0.03 inches of commercial tin plate per container.

3.23 The diameter or width of the containers must be within the ranges of 1-1/2 to 12 inches.

3.24 The CONVEYOR SYSTEM is probably the biggest factor in determining the degree of accuracy obtainable with the inspection unit. Under ideal conditions the variation of fill level required to produce rejection may be as small as ± 1/64 inches. In practice, however, fill material ripple, jamming, inadequate spacing, etc. are all factors which can reduce the accuracy of the inspection process. The following paragraphs will point out the conveyor requirements desirable for optimum performance.

3.25 The approach to the inspection position should be so designed that the containers pass through the inspection position in single file and not staggered or crowded sidewise. Crowding can be prevented by guide rails which start several feet before the inspection position so as to gradually guide the containers into line without jostling them. In addition the guide rails should be arranged so that under no condition will containers be able to strike the crystal or phototube housing.

3.26 For at least six feet the approach to the inspection position should consist of a smooth, ripple free, straight length of conveyor free from any obstruction (markers, bulge detectors, etc.). If in doubt the amount of ripple or disturbance can be determined by watching an open top container filled with water as it rides along the conveyor.

3.27 Although containers may be presented for inspection at random they must pass through the inspection position with a minimum of 1/8" spacing between them. Most containers have rims which auto-

matically provide this minimum spacing. However, the containers must not be allowed to jam together so the rims of one container override the rims of another. This condition can be prevented by one of several methods:

a. Mounting a top guide rail which starts several feet before the inspection position and prevents the containers from rising high enough to do this.

b. Speed up the section of conveyor passing through the inspection position so that it is faster than the speed the containers are being fed onto the conveyor.

c. Mounting a star wheel, or can spacer, on the conveyor. However, star wheels or can spacers jostle the containers quite severely and must be placed at least 6 feet ahead of the inspection position.

3.28 Certain containers do not have rims to provide the required 1/8" spacing. Adequate steps to prevent bunching and ensure adequate spacing must then be provided. The steps outlined in paragraph 3.27 (steps b or c) should provide a suitable arrangement.

3.29 The possibility of jams or slow downs which occur after the inspection position, allowing containers to back into the inspection area, should be prevented by providing a pressure switch as far as possible past the inspection position. The switch should operate a solenoid operated "stop" several feet ahead of the inspection position. Another method is to provide a "breakout" section in the guard rails past the inspection position to allow excess containers to be pushed onto an accumulating table rather than cause a jam.

3.30 When physical rejection of unacceptably filled containers is desired, it may be necessary to remove a small section (approximately three container widths in length) of the guide rails at the point at which rejection will occur. Also provisions for mounting a reject chute to the conveyor assembly may be advisable. The chute should be covered to prevent the rejection of a completely empty container from becoming a dangerous missile.

3.31 SPECIAL TOOLS that should be available for the installation are:

a. Wand handle Fluoroescent Screen Probe (supplied with equipment). G.E. X-Ray Catalog #1003909G1

b. Ruler, 12 or 15 inches long.

c. Ruler, 1/32 inch divisions, steel (desirable length will vary with type of conveyor and product).

d. Pinch clamp (needed only if expansion tank oil hose is replaced).

e. Carpenter's Square.

f. Level.

g. Volt-ohmmeter, at least 20,000 ohms per volt.

h. Flashlight.

i. 7 and 9 pin Hytron Tube Test - Adapter Sockets.

3.32 Spare Parts

a. The Hytafill is a production tool for use over an extended period of time for production purposes. So that "down time" may be kept to a minimum, it is recommended that at least a basic set of spare parts be procured with the basic Hytafill. Such parts are not included as part of the Hytafill itself and must be ordered as a separate item. The following parts are available:

Item	Cat. No.	Description
1	T0001CD	Spare Parts Kit (Includes complete set of tubes for single channel unit,all plug-in components, fuses, lamps, and shutter relay.)
2	T0001CE	Spare Parts Kit (Includes one of each value of resistors and capacitors not included in T0001CD as plug-in components.)
3	T0001CF	Spare Parts Kit (Includes three crystal assemblies for single channel unit.)
4	T0001AG	Spare Parts Kit (Includes three crystal assemblies for dual channel unit.)
5	282D718G1	Electronic Chassis, complete with tubes and plug-in components.
6	4000412G1	X-Ray Tube Head, complete with x-ray tube and oil, but less detector.

7 3000683G1 Phototube Chassis, complete with tubes.

b. It is recommended that all users of Hytafills procure Items 1, 2, and either 3 or 4, whichever suits the user's equipment. Items 5, 6 and 7 may also be stocked at the user's discretion for use as spare components which may be of great value in returning the equipment to operation as rapidly as possible. Justification for stocking these items will depend on the amount of use the equipment receives and the amount of maintenance time that can be tolerated by the user. For example, a spare electronic chassis may be installed in a single channel control and adjusted for proper operation. It should then be necessary only to move the fanning strip from the defective amplifier to the spare to return the equipment to operation.

c. It should be remembered that individual items may be readily ordered separately to keep the Spare Parts Kits as complete as possible. All functional parts for the Electronic Chassis, X-Ray Tube Head and Phototube Chassis are also immediately available so that a defective unit may be repaired as expediently as possible and returned to the user's spare stock.

4.00 INSTALLATION - GENERAL

4.01 Although these directions are sufficiently explicit to permit an electronic technician of average experience to make the assembly and adjustments, it is strongly recommended that the work be done by a General Electric Company, X-Ray Department representative who has been especially trained for this work.

4.02 THE GENERAL ELECTRIC COMPANY IS NOT RESPONSIBLE FOR GOODS LOST OR DAMAGED IN TRANSIT. The Company's responsibility for safe delivery ceases when the transportation company accepts shipments in good order. All packages should be closely examined at time of delivery. If damage is apparent, have notation of "bad order" made on freight or express bill. If damage is of a concealed nature, notify transportation agent not later than fifteen days after delivery giving him an opportunity to make inspection and issue a "bad order report". A transportation company usually will not pay a claim for concealed damage if an inspection is not requested within fifteen days after delivery of the shipment.

4.03 While it is the consignee's responsibility, upon request we will help the customer in filing loss or damage claims. Complete instructions regarding claim procedure are found in Section "S" of the Policy & Procedure Bulletins, published by the General Electric Company, X-Ray Department.

4.04 Preparations for Installing the Tube Head:

a. The tube head must be mounted on a mounting platform (supplied by the customer) alongside the conveyor in such a manner that the inspection hood extends across the conveyor. The position of the head with respect to the distance to and height of the conveyor and the location of the head with respect to conveyor length and other attachments are exceedingly important and the choice of location can "make or break" the success of the installation.

b. Since conveyor assemblies are not standard, it is extremely difficult to provide explicit instructions which, if followed, will assure perfect operation. There are, however, a number of general considerations which, if carefully and intelligently observed, will save many many hours of trouble-shooting. Careful observation of operation during and after installation and the application of a little ingenuity and common sense will thereafter develop ready solutions to those problems which a particular type of conveyor may present. If, perchance, the Hytafill is to be installed on a conveyor already in operation, it will be well worth while to watch its operation--in advance of the Hytafill installation--to observe and study the degree of smoothness of operation, the amount of container jostling, and the effect and locations of stoppages. Such a careful study will frequently indicate locations of preference for the Hytafill and any modifications which might be necessary and can be accomplished while the Hytafill is being installed.

4.05 Location of Tube Head along the Length of the Conveyor.

a. The final inspection accuracy will be dependent on the roughness of the conveyor and any jostling which the container may undergo just prior to inspection.

1. The roughness of the conveyor is a factor which can be fully evaluated only after the unit is installed and it is suggested that the installer not be too concerned about this unless the conveyor is observed in advance of installation and found to visibly jiggle the cans. If such is occurring the customer should be advised so that he may choose to perform service to the conveyor either during installation of the Hytafill or after accuracy checks are made. In general, if the conveyor is shut down for a period to allow the Hytafill installation (such is not absolutely necessary), it would be wise for the customer to clean and grease the conveyor at the same time. If the conveyor is

of the stainless steel variety, the "belt" should be removed and each joint carefully inspected and cleaned to obtain freedom of motion. More data on the effect of the conveyor is provided in the remainder of Section 4.00.

2. The effects of physical jostling of cans by other conveyor accessories, such as star wheels, turn-tables, bulge detectors, etc., must be eliminated before the containers pass through the Hytafill. An excellent rule to follow is to locate the Hytafill or relocate these accessories so that they are no nearer the Hytafill than six feet. This is important. Since it may be found necessary to add a star wheel to space the cans (particularly for cans with no "lip" on either top or bottom), it is preferable to plan at least 8 feet to allow such addition without compromising the final requirement for six feet distance.

b. The conveyor must be arranged to present the containers to the Hytafill in single file, with no less than 1/8" spacing. Experience dictates that any neglect to assure this condition consistently will result in trouble and misunderstandings.

1. The requirement of presenting the cans in single file is easily handled by asking the customer to install two guide rails, one on each side of the conveyor starting at least two feet ahead of the Hytafill to avoid jostling, to guide the containers into single file. If more than one size of container is to be inspected by the Hytafill (in separate lot runs, of course) these guide rails can be made adjustable to provide proper operation with each type of container. Since the height of these rails will depend also on the height requirements of the Hytafill it may be found most expedient to have the customer provide the rails after the final location and height of the tube head is ascertained.

2. The requirement of 1/8" spacing between containers can be rather difficult to obtain on some conveyor systems and may require rather major modifications. If the containers to be inspected do not have lips, top and/or bottom which should keep the containers separated, a star wheel must be installed (at least six feet from the Hytafill) or the belt speed of the conveyor increased sufficiently above the speed of can delivery to automatically provide this spacing. Belt speed, however, should not be increased over that which allows the container to be inspected for a period of 1/15th of a second (4 x-ray pulses).

3. If the containers do have lips which will normally provide the minimum of 1/8" spacing, an arrangement still must be provided to prevent the lips of one container from overriding the lips of the next, thus allowing a reduction of spacing below the prescribed 1/8". This can be readily provided by asking the customer to install a bar over the center of the conveyor extending from at least 2 feet in advance of the Hytafill to just beyond the Hytafill hood, and at a height just above the level of the tops of the container. To prevent difficulties with bulged containers, the container must have previously been passed through a bulged can detector.

4. Regardless of the type of container to be inspected, bunching and jamming of containers into the Hytafill area must be prevented. On some conveyor systems, observations of the conveyor in operation prior to Hytafill installation will indicate a position along the length of the conveyor at which no containers appear to bunch up. That is, any jams that occur result in conveyor stoppage in a manner such that all containers pass out of the area before being jammed. This is the desirable condition to achieve. On conveyors not so blessed, however, it will be necessary to have the customer provide other arrangements. A number of schemes have been utilized successfully, each based on the use of a pressure switch strategically located at the point on the conveyor where the jams occur. This switch generally actuates an electrically controlled star wheel or a solenoid "stop", at least 6 feet ahead of the Hytafill, or in some cases shuts off the conveyor feeding the one on which the Hytafill is located. Either system has been made to operate satisfactorily, and either can be used as long as the end result is achieved.

4.06 Location of the Tube Head Crosswise to the Conveyor:

a. In order to obtain maximum usefulness from the x-ray beam which emerges from the port on the front of the tube head, the tube head and conveyor should be arranged so that the containers pass through the unit as close to the face of the tube head as possible without striking the head, and still allow space for the air nozzle and the head to be raised and lowered and tilted without ever touching the conveyor.

b. If the conveyor is wide, requiring the use of guard rails to keep the containers in single file, these guard rails should be arranged so that the containers pass through the Hytafill on that

side of the conveyor belt nearest the face of the tube head. The guard rails on either side of the conveyor should also be arranged so as to prevent the containers from ever striking any portion of the tube head or hood.

c. Sufficient space should be provided between the head, in its lowest position, and the conveyor so that the air nozzle will never strike the tube head. The air nozzle or air valve must not be mounted on or attached to the head or its platform. The position of the air nozzle with respect to the tube head is shown on Drawing 4936-D10.

4.07 Location of the Tube Head in Height, with Respect to the Conveyor:

a. Once the location of the Hytafill tube head with respect to the lengthwise and crosswise dimensions of the conveyor is selected arrangements can be made to modify the guard rails, etc. to meet the height requirements.

b. The height of the tube head is adjustable over a 3" range. The basis for establishing approximate height requirements is the level of inspection. This can be established approximately from the customer or by opening a properly filled sample, setting it on the conveyor and measuring the level of fill over the conveyor belt. Now, for test purposes it will occasionally be found desirable to lower the tube head by as much as 1-1/4" below this level.

c. All side guard rails through the Hytafill must be lowered to a level which will not interfere with the phototube light beam--with the head set at this lower level. At first, this level may seem too low to be useful; however, this low level is required only in the Hytafill hooded area itself. Guard rails up to the Hytafill hood should be at normal height as used elsewhere on the conveyor.

d. It is important that at least one guard rail on each side of the conveyor pass completely through the Hytafill inspection position to prevent the possibility of containers striking any part of the tube head and its hood.

e. Further, the top guard rail mentioned previously to prevent the overriding of can lips, should be supported from side posts mounted to the conveyor just outside the Hytafill area. This guard rail should also pass clear through the inspection position. Sufficient space should be provided between the side and top rails to allow a person to reach in and extricate jammed con-

tainers, should they occur.

f. An opening approximately 13" long should be cut in the guard rail on the opposite side of the conveyor from the air nozzle to allow for rejection of cans. At the time this is done, it may be found convenient to have the customer also make up a 24" long bar which can be temporarily spanned across this opening should it be desired during the test period to prevent cans from being shoved out this opening.

4.08 Location of Air Reject Apparatus:

a. As discussed before, the air nozzle must be located between the tube head and the conveyor, at a position so as to reject containers just as they emerge from the inspection position. Since the exact position will depend on the time required for the air valve to operate and for the air to get to the container, it will be necessary to finally locate the nozzle experimentally after the Hytafill is installed. The approximate position, when a Beckett Harcum 3/4" valve is used, is approximately halfway between the phototube window and the outer edge of the phototube housing coverplate.

b. In asking the customer to construct and install this mechanism the following factors should be given careful consideration:

1. The reject system may occasionally be required to reject large quantities of containers. The air supply, therefore, will be required to provide a large volume of air continuously at 75 to 100 lbs. per square inch. Since the ability of an air supply to do this will depend on the length of runs, the actual pressure involved, the number of bends, etc., it is impossible to specify in advance the actual pipe requirements other than to advise that reasonable intelligence be used in selecting pipe sizes and actually routing the air lines. A reservoir installed in the air line close to the air valve will help maintain air pressure during repeated rejections and is highly recommended.

2. High speed solenoid air valves are not mechanically perfect and will require periodic service. The greatest need is for cleaning and oiling to keep the performance consistent. The frequency of this service will be reduced if an air filter and a lubricator is installed in the air line just ahead of the air valve. Recommended air valve size, as previously noted, is 3/4". It is recommended that the customer keep a spare air valve on hand for rotational replace-

ment for service. Air line fittings should be arranged to allow ease in replacement of the valve.

3. The air line between the solenoid air valve and the nozzle should be of at least 3/4" size, should be as short as possible and consist of two parts; a short length of flexible air (or hydraulic) hose, and the nozzle itself. The coupling of the flexible air hose at the solenoid air valve should allow ease in uncoupling to replace the valve.

4. The nozzle itself should be made up of thin wall copper tubing to reduce the space requirements between the head and the conveyor. The tubing can be closed just above the air jet either by a pinch-solder seal or by a plug soldered in place. Air jet size can be as indicated on Drawing 4936-D10. This size works well with 12 oz. cans. If the container is larger or smaller, the size can be changed experiementally to provide rapid, crisp rejection.

5. The nozzle can be mounted to a plate welded to the conveyor frame with such a fitting that will clamp it tightly to prevent undesirable movement during operation. By loosening studs, however, it should be possible to adjust the position of the jet vertically, horizontally along the long dimension of the conveyor, and in rotation so that the jet can be aimed away from the tube head in the direction that the containers are moving. Ingenuity will be required to match this assembly to the physical size and shape of the conveyor at the chosen location and height of the head. It will probably be found more convenient to complete the details of mounting the nozzle prior to moving the tube head and its platform permanently into position. It may, however, be desirable to temporarily position the tube head--in advance of final installation so that the customer can visualize the space requirements, then move the head to install it.

6. As noted in Drawing 4207-D11, it is highly recommended that a switch and pilot light be connected in the electrical circuit to the solenoid air valve. The pilot light, in particular, should be located so that it can be seen over as wide an area as possible, particularly from the control and the tube head. The switch should be readily available from each, also, with a slight preference to the control. If the distance between the head and the control is large, it may be found desirable to use two switches, one at the tube head and the other at the control, connected in a

typical two-way-control circuit allowing either switch to turn the solenoid power ON or OFF.

4.09 Tube Head Mounting:

a. The tube head is shipped with the x-ray tube, the expansion tank, and the adjustable mounting base assembly installed. Both tube head and the expansion tank have been properly filled with oil.

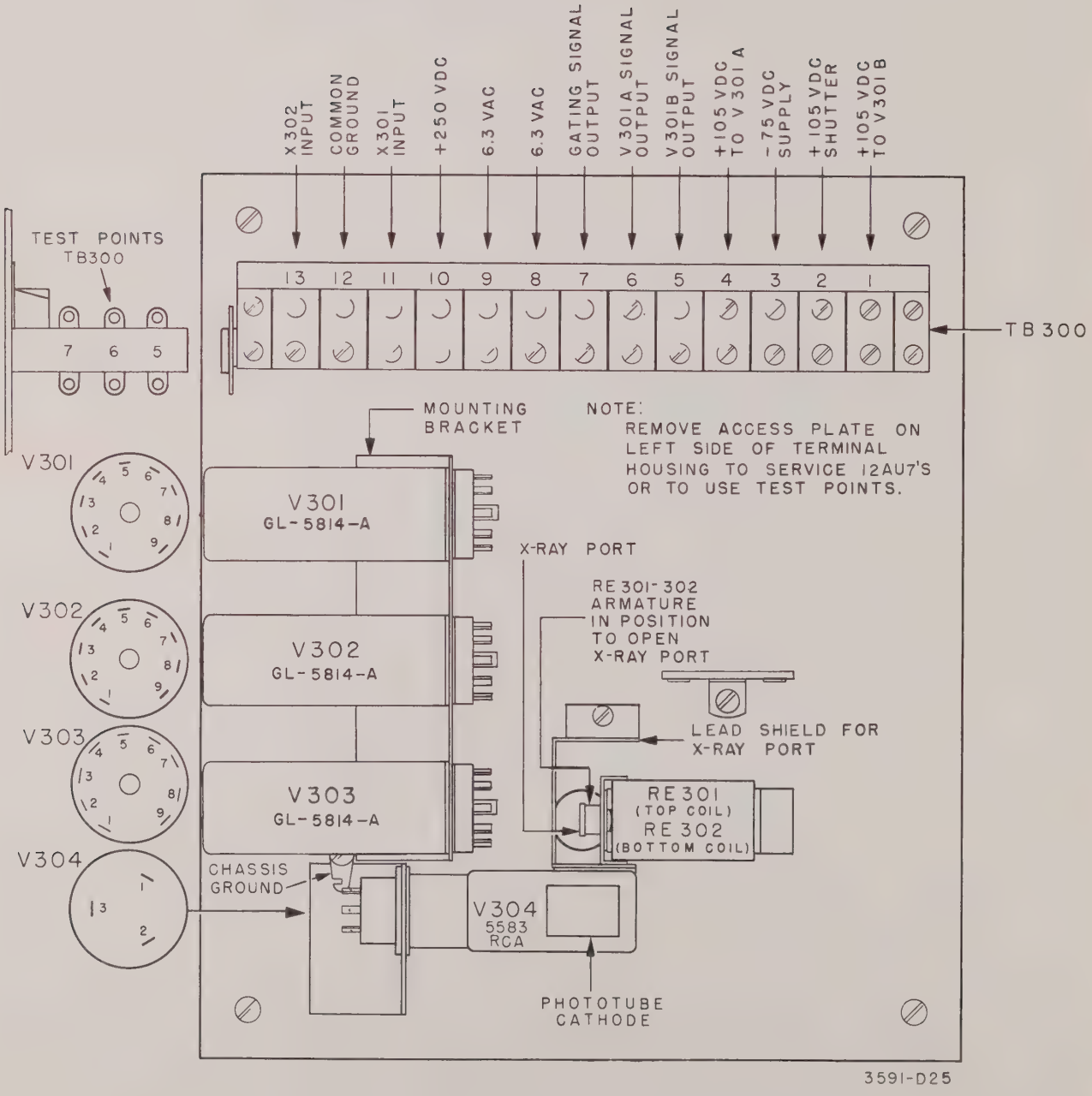
b. Move the customer's mounting platform into the approximate final position and place the tube head assembly on it. Secure the tube head base assembly to the platform using only the four inside holes.

c. Remove the expansion tank cover by removing the four #6-32 x 1/4" machine screws located at the base of the expansion tank. Then place the lead disc (packed separately) on top of the neoprene expansion bellows, forming the bellows, if necessary, to conform to the shape of the circular boss on the lead disc (the boss is placed downward against the bellows). When the tube head is at room temperature, the bellows should be easily compressed. Replace the expansion tank cover.

d. The tube head is mounted to its base frame with a hinge and supporting latches, allowing the head to be tilted up, lifting its hood above the conveyor. If installation occurs while the conveyor is in production use, the head may be tilted to allow further assembly and testing to be performed without interference with production.

e. Now remove both sections of the phototube chassis coverplate. Carefully inspect the phototube chassis visually to determine that all components are in good condition, that all soldered connections appear satisfactory, and that all screws and nuts are tight. Remove the rubber band which secures the shutter pivot pin during shipment. If the tubes were shipped separately, install them per Drawing 3591-D22. Except for special applications as described in paragraph 5.02e, V303 should be removed.

f. Clean the glass envelope of the phototube so that maximum light may impinge on the phototube cathode surface. Check the phototube clamp to make sure that the phototube is tight and cannot move. Also check that the phototube cathode is faced outwards and is not rotated along its long axis. The cathode is the brownish rectangular "plate" bent to form a semi-circle (end view).



PHOTOTUBE CHASSIS

4.10 Assembling the Stabilizers to the Control:

a. The Type 2 Hytafill is provided with two 500 VA stabilizers intended for mounting in the control. These stabilizers are connected in parallel via the associated harness to provide a total of 1000 VA to provide power for the entire Hytafill unit with the exception of the rejection circuit providing power to the air reject mechanism.

b. Since the stabilizers normally operate at relatively high temperatures, the fan is provided to improve the ability of the cabinet to dissipate the heat generated within it when it is closed.

c. The stabilizers are relatively heavy and the easiest method for installing them in the control cabinet is to lay the cabinet on its back on the floor. Prop open the door and the hinged chassis structure and insert the stabilizers one at a time, attaching them to the bosses on the side panels of the cabinet using the screws provided. Now close and secure the hinged chassis frame and the door of the cabinet.

d. Place the control platform, provided by the customer in a position adjacent to its selected position on the production line. Place the control on the platform and fasten it securely to the platform with bolts through the holes in the control base frame.

CAUTION: Do not swing the hinged chassis frame out unless the control cabinet is fastened to a rigid mounting. With this assembly swung out, the cabinet is off-balance and is apt to fall forward at any time, even with the stabilizers mounted inside.

4.11 Mounting the Control Unit:

The control can be located in any convenient place within a distance such that the head-to-control cable will not exceed 50 feet in length. There are, however, certain advantages to locating the control in a particular area and faced in a particular direction. A study of the physical layout of the customers plant, with respect to the following considerations may be helpful in determining the best location.

a. The control is equipped with two indicating lights plus a neon bulb in each amplifier. The neon bulb in particular offers partial assurance that the unit is capable of rejecting low filled containers. There would, therefore, be an advantage to having

the control face the nearest operator (such as the pasteurizer operator, if a beer installation, or the filler operator in others). This operator could occasionally check to see that the neon light is indicating properly.

b. For dual channel units, there is one definite advantage in using the amplifier neon indicators during the crystal alignment procedure to obtain an optimum position for both crystals. Although it is not expected that crystal alignment will be performed frequently, this factor should be evaluated in conjunction with (a) above to obtain the optimum control position.

c. Although test terminals are available at the tube head (through the access port on the left side of the phototube housing) to which meters can be connected for phototube-light and crystal alignment, it is sometimes easier to pick up these terminals at the control, standing the testmeter on top of the control. It would, therefore, be an advantage to have the control located sufficiently close to the head so that the testmeter can be read from the head.

d. For obvious reasons, it is advantageous to locate the control in an area of fairly good illumination and where access to its internal parts will not require moving the entire control.

4.12 Preliminary Electrical Assembly:

With certain special exceptions, all electrical connections can be made with the aid of the Interconnection Diagram, Drawing 4953-D40. Conduits and other external connections to the line switch and accessories are shown on this drawing.

a. Before proceeding, recognition should be made of the fact that the Type 2 Hytafill is normally provided with only one amplifier, mounted in the bottom amplifier position of the control. The connecting harness for this amplifier is so connected to the control that it provides all the d-c power for those circuits in the tube head and control panel itself, that require such power and that this harness is always associated with the underfill detecting crystal (or lower crystal on dual channel units). Connections are made in this manner on the assumption (based on experience) that, in most applications of the Hytafill, it is particularly desirable that underfill operation be consistently maintained, even at the expense of demobilizing any overfill amplifier, that may be utilized in the upper amplifier position. With these connections, a failure in the lower or underfill amplifier can be quickly offset by shifting the connecting har-

ness to an amplifier in the upper position, regardless of whether the upper amplifier is in normal use for overfill inspection or simply in this position as a spare.

b. Although the second amplifier, intended for mounting in the upper amplifier position on the control panel, is normally supplied with an interconnecting harness and a dual crystal housing assembly for use in providing both over and underfill inspection, neither the extra harness nor the dual crystal housing should be connected in if the customer's desire for the second amplifier is purely to have available a spare amplifier. To connect in these parts under these circumstances serves merely to complicate the wiring and confuse personnel providing later maintenance. It would, however, be well to retain these items for future use should the customer ever decide to attempt dual channel operation.

c. If, on the other hand, the customer initially desires dual channel operation and the unit is so connected, but the customer later finds that overfill inspection is no longer desirable, it would be well for the serviceman to remove the upper amplifier harness and reinstall the single crystal housing assembly to remove these confusing elements for the benefits mentioned above.

d. Before doing any wiring within the control or tube head, visually check all connections against the X-Ray Control - Elementary Diagram (Dwg. 4474-D41) and the Electronic Schematic (Dwg. 4480-D51). Check all connections (except those at TB200, TB300, and TB500) for tightness. Several hours spent at this time may save many future hours of trouble-shooting.

4.13 Interconnections Within the Control:

a. Check the wire and terminal markings and connect the stabilizers and their wiring harness, to the control as shown in the Interconnection Diagram, Drawing 4953-D40.

b. If a second amplifier, harness, and crystal are to be used to provide overfill protection, unpack and carefully inspect the additional amplifier and its harness.

1. Remove the blank panel used to fill the position in the control intended for the overfill amplifier.

2. Mount the second amplifier in its final position in the control. Attach the fanning strip end of the wiring harness to

the amplifier, then tighten all screws on the terminal strip. Recheck.

3. Recheck the wire markings on the wiring harness and connect as shown in the wiring table below. After making several connections, mechanically check, by swinging closed and then opening the main control panel, that the routing of the harness is satisfactory and results in minimum rubbing or interference of the harness, or its individual wires, to swing the main panel open or closed.

4. When a satisfactory routing of the cable is achieved, complete all the connections and recheck.

TABLE OF CONNECTIONS

Amplifier Terminals	Circuits Involved	Control End of Harness	
		Overfill Amplifier	Underfill Amplifier (for checking purposes)
1	115-v counter	34	34 (via TB100-7)
2	115-v common	33	33
3	115-v input	39	39
4	Ground	10	10
5	6.3 volt for head	-	18
6	6.3 volt for head	-	19
7	No connection	-	-
8	No connection	-	-
9	No connection	-	-
10	Reject NO contact	4	1
11	Reject (common) contact	5	2
12	Reject NC contact	6	3
13	Counter	30	31
14	+105-v d-c	15	14
15	+105-v d-c	-	16
16	-75-v d-c	-	13
17	Phototube Gate Input	17	17
18	No connection	-	-
19	+255-v d-c	-	20
20	Crystal signal input	12	11

c. With the above connections, if a failure occurs in the lower amplifier chassis, its fanning strip of connections can be shifted to the upper chassis, the upper chassis set on Underfill,

rapidly recalibrated using the test panel, and the Hytafill returned to inspecting condition in a minimum of time. The fanning strip formerly connected to the upper amplifier can be connected to the lower amplifier or can be supported so that its lugs do not touch any metallic object. The faulty lower amplifier can then be removed for shop-service elsewhere or left in place for service during an off-production maintenance period. If care is utilized, the power to the Hytafill need not be OFF when a fanning strip is shifted from one amplifier to another.

4.14 Now proceed to connect the control to the tube head, line supply, line voltage stabilizer, water solenoid, and reject system as per the Hytafill Interconnection Diagram, Drawing 4953-D40. It is strongly suggested that, before the leads are connected to the terminals, they be checked for continuity, end to end, and between ground. (If the standard head cable is used, all conductors are #16 wire; therefore, two #16 wires are used in parallel for each conductor requiring #14 wire as listed in Table I.)

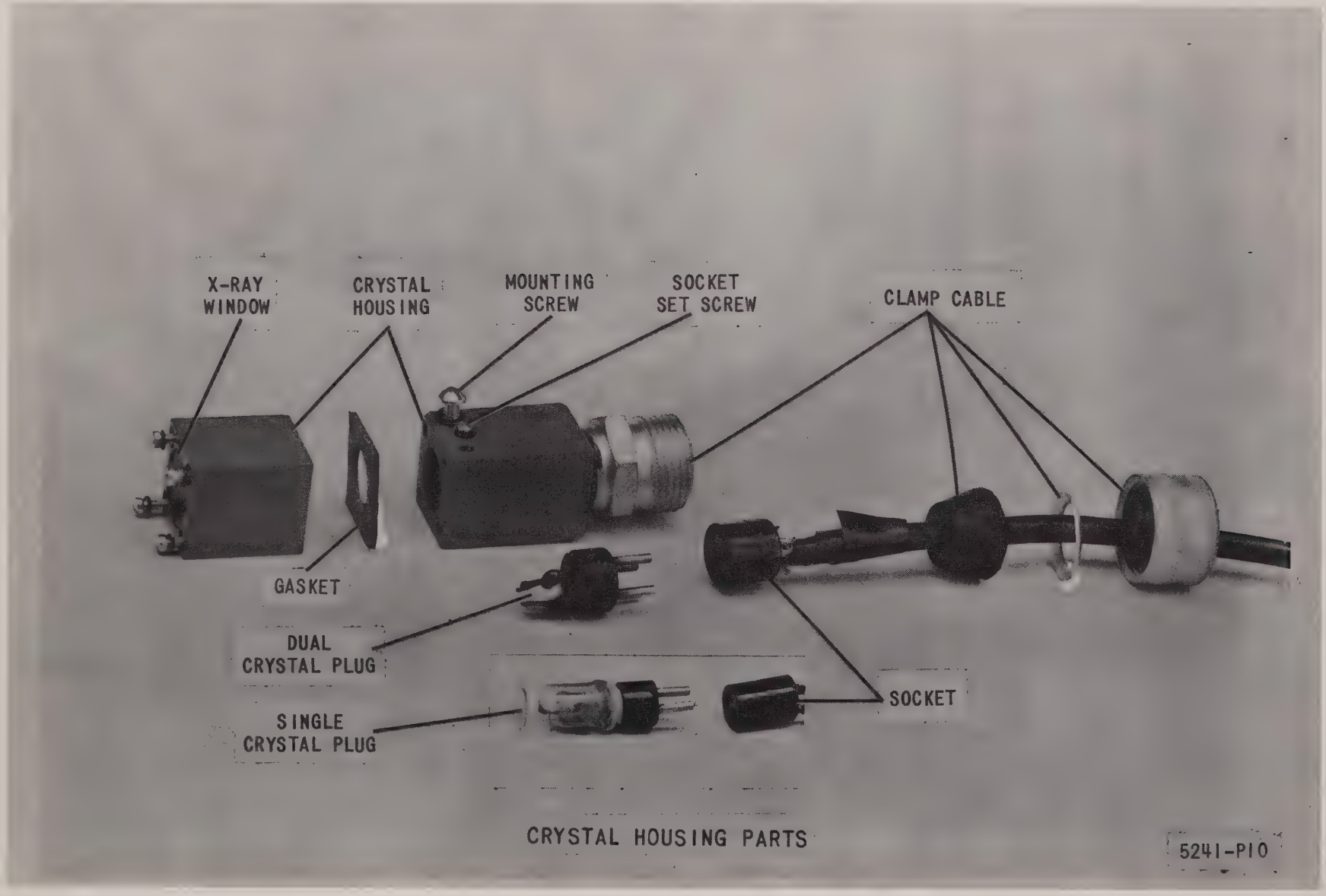
4.15 Check to be reasonably certain that the grounding lead to TB500-9 is well connected to a good ground. This lead should not be fused under any circumstances and it should not be connected to any line which also acts as the grounded side of a 115-v circuit. Conduit or water pipe grounds may be satisfactory for the Hytafill, but should be considered suspicious if trouble occurs and until proven otherwise.

4.16 When making connections to the tube head, adjust the spacing of the pointed copper strip on the TB200-MA terminal so that the spacing between the point on the copper strip and the tube head terminal steel housing is 0.010 inches. A feeler gage should be used for this purpose. This adjustment provides the surge gap which protects the ma metering circuit in the center grounded high-voltage transformer secondary circuit. Also make certain that the copper strip on the TB200-GND terminal is making solid electrical contact with the grounded metal of the tube head terminal housing. Clean and scrape the grounding strip area of contact on the tube head if necessary.

4.17 Detector Hood Assembly and Connections:

Unpack the crystal housing and the hood assembly.

a. If the single crystal assembly is to be used, remove the front cover with the plastic port. Check the port to be certain that



CRYSTAL HOUSING PARTS

5241-P10

it is not loose and provides a good light-tight seal. Check the crystal cable wires and socket for continuity, end to end, and for insulation between each other and the shield. Now remove the sealed crystal from its container and packing. Note how both the crystal plug and crystal socket are "polarized" to allow only one way of assembling. Plug the crystal into its socket and check its position and the housing to assure that when the front cover is installed the cover will not press against the crystal sealing envelope. Now re-install the crystal housing cover, making certain it seals tightly so that it will be light-tight.

Set the assembly aside for the moment in a safe place.

b. If a dual crystal assembly is to be used, remove the front cover with the plastic port. Check that the port is not loose and provides a good light-tight seal. Check the crystal cable wires and socket for continuity, end to end, and for insulation between each other and the shield. Remove the dual crystal assembly and crystal socket. Check the position of the crystal and the housing to assure that when the front cover is installed the cover will not press against the crystal assembly. Now re-install the crystal housing cover, making certain it seals tightly so that it will be light-tight.

NOTE: THE DUAL CRYSTAL DETECTORS ARE EXTREMELY FRAGILE AND MUST BE HANDLED WITH CARE AT ALL TIMES. EXCEPT TO ADJUST THE THE SPACING BETWEEN CRYSTALS OF A DUAL CRYSTAL ASSEMBLY, THE CRYSTAL SHOULD NOT BE TOUCHED.

Set the assembly aside for the moment in a safe place.

c. Take the hood assembly and position it into the normal position it will take when attached to the tube head. The crystal housing and light housing are mounted on brackets which can be positioned within the hood so as to allow the inspection of containers of various sizes. The wrap-around protective shield is also adjustable. With the hood in its normal position, establish the extent of adjustment, if any, that will be required for use on the particular conveyor with the particular type of container. Now remove the hood and take off the protective shield. Reposition, if necessary, the crystal housing bracket and the light housing bracket.

d. Now mount the crystal housing on its bracket using the screws and lock washers provided. Route the crystal cable through the grommet on the left side of the hood. Now prop or tie the hood up to the top side of the head so that the crystal and light cables will be within reach of the terminal strip within the phototube housing via the left side waterproof access ports. Assemble the waterproof connectors onto the cables, feed the cables through the left-side cable access holes and loosely attach the waterproof fittings.

e. Connect the two cables to the terminals indicated, pull all slack of the cables out of the housing and tighten the waterproof connectors. The hood is later assembled to the head during the Tests and Adjustments which are to follow:

FINALLY RECHECK ALL CONNECTIONS, MAKING CERTAIN THAT ALL ARE TIGHT AND THAT ALL TERMINAL LUGS ARE SECURE AND DO NOT TOUCH ADJACENT LUGS.

5.00 HYTAFILL INSPECTION METHOD

5.01 Principles of Inspection

Basically the Hytafill Inspection Unit functions as a "go-no go" gage. Within limits, determined by the inspection unit, conveyor conditions, etc., it will indicate or provide a reject signal if the level of the fill material is unacceptable.

a. The basic principle of the Hytafill method for inspecting the height-of-fill in sealed containers is illustrated in Figure A and Figure B, Drawing 3594-D10. When the unit is adjusted to monitor underfills, the first essential condition is that the center of the collimated x-ray beam must pass through the container parallel to and just below the correct level of fill. The minute crystal detector must then be placed so as to intercept the x-ray beam and detect changes in the impinging x-ray intensities. If the x-ray beam sees container only, the x-ray intensities impinging on the crystal are greater than when the beam sees container plus fill material. For overfill inspection, the collimated x-ray beam must be essentially parallel to and just above the correct level of fill. The location of the crystal is then just above the correct fill level. It is the crystal's electrical response to changes in impinging x-ray intensities that develops the signals which when amplified determine whether or not the reject mechanism will be energized.

b. During the initial tests and adjustments, the operating primary volts and ma for the x-ray beam generator are selected so that crystal signals representing correct fill levels will not be of sufficient magnitude to initiate the reject action when the amplifier is set to monitor underfills. The operating primary volts and ma, however, must generate an x-ray beam of sufficient intensity and penetrating power so that the crystal signals representing container only will be of sufficient magnitude to initiate a reject action. The intensity of the impinging x-rays on the crystal is a function of the primary volts and ma of the beam generator and of the absorption experienced by the x-ray beam between the x-ray tube target and the detector crystal. Raising the primary volts increases both the intensity and the penetrating power of the x-radiation. Raising the ma increases the intensity only. When the x-ray beam sees both container walls and fill material, it experiences greater absorption than when it sees container walls only.

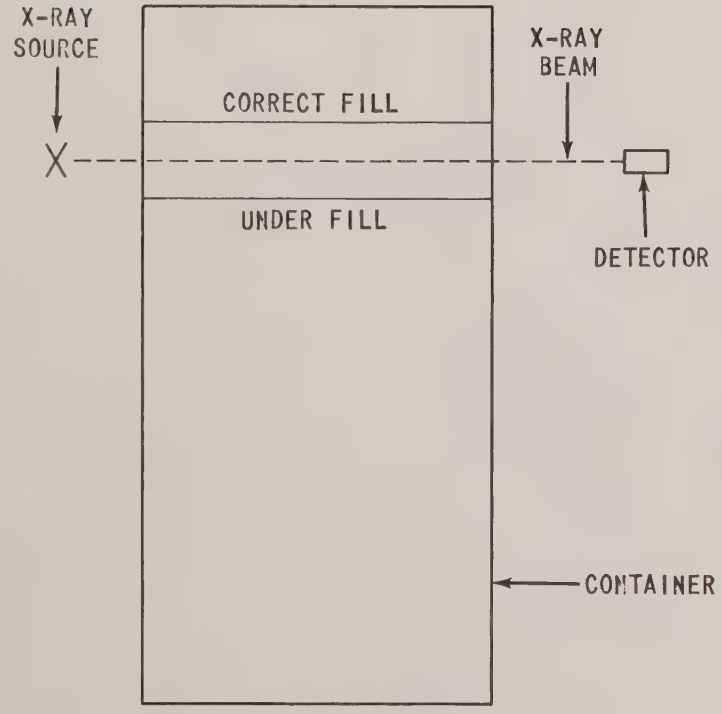


FIG.A - METHOD FOR X-RAY INSPECTION FOR UNDER-FILL CONTAINERS

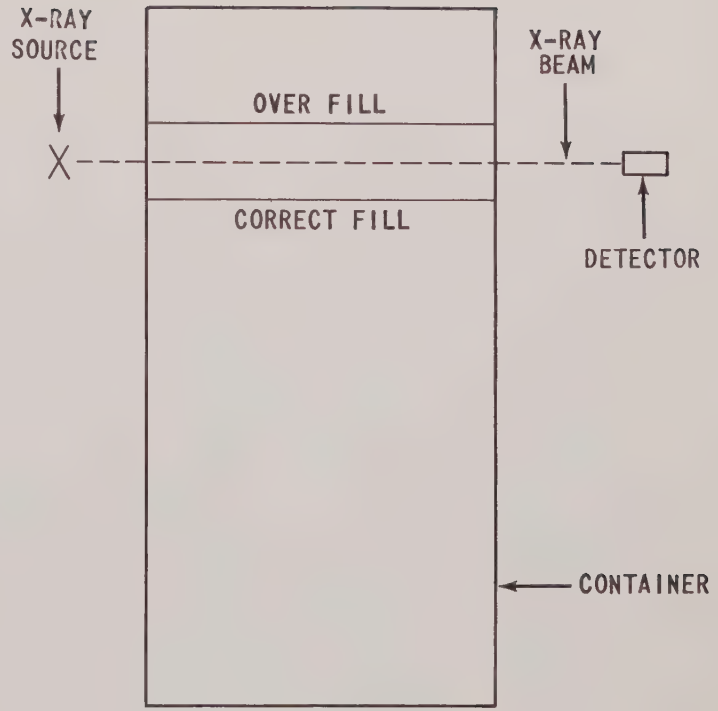


FIG.B - METHOD OF X-RAY INSPECTION FOR OVER-FILL CONTAINERS

3594-D10

c. When the dual channel gage is used, two crystals are placed in the crystal housing. The underfill inspecting crystal is placed just below the correct fill level, and the overfill inspecting crystal is placed just above the correct fill level. The height of the tube head is adjusted so that the center of the x-ray beam is half way between the two crystals. Simultaneous inspection for both overfill and underfill conditions is made possible by the proper selection of crystal signals for the two amplifiers provided with the dual channel gages.

d. Random spacing of containers is permissible because of the use of a phototube gating circuit. The gating circuit makes the amplifier insensitive to the crystal signal until after the container is well into the inspection position. This controlling action is required because of the short time interval that each container is under inspection and the fact that the electrical resistance of the crystal does not instantaneously change with changes in impinging x-ray intensities. Although the crystal response is rapid when radiated with pulsed x-radiation a finite time is required to change from one conduction state to another. Therefore, the gating circuit must make the detection circuits insensitive until after the state of conduction of the crystal correctly represents the filled (or unfilled) containers. In special applications where heavy-walled containers are used, the required change of crystal resistance is too great to be accomplished in the required time. In these cases, a shutter which is actuated by the gating circuit is used to simulate the absorption of an empty container when no container is in the x-ray beam. In this way, the conduction change required of the crystal is kept within usable limits.

e. One functional requirement of the x-radiation is that its path must be essentially parallel with the level of the correct height-of-fill. Collimation of the x-radiation into a 5/16" x 3/32" rectangular beam (at the tube head port) is used primarily for x-ray protection. The crystal housing absorbs the primary x-ray beams, and the steel detector housing assembly absorbs scatter radiation. Collimation of the x-radiation also reduces scattered radiation that might impinge on the crystals causing meaningless crystal signals.

5.02 The Crystal Signal

a. Cadmium selenide crystals are sensitive to both light and x-rays. The crystals used in the Hytafill are pre-selected for their sensitivity to x-rays of the wavelengths produced by the Hyta-

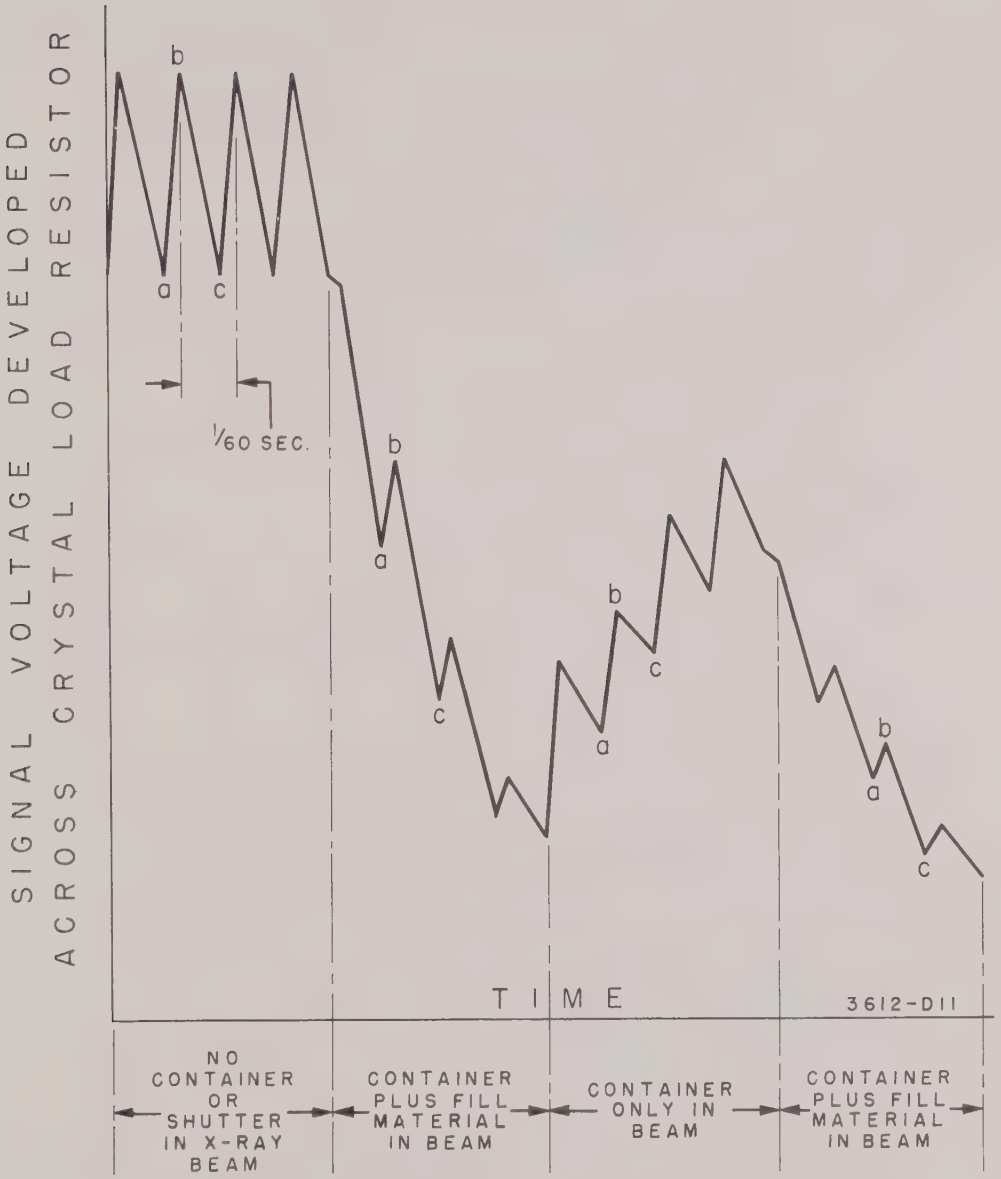
fill's x-ray beam generator. The crystal is mounted in a light-proof housing to eliminate the effect of light upon its electrical resistivity.

b. The self-rectifying SPI-100 x-ray tube generates x-rays only during the positive portion of the 60 cycle voltage impressed across the high voltage transformer in the tube head. For this reason, the x-ray pulses occur at a rate of 60 per second. Since a signal load resistor is connected in series with the detector crystal across a d-c supply voltage, the crystal signal consists of a-c and d-c components. The crystal and its load resistor act as a voltage divider. When the impinging x-ray intensities are of low magnitude, the crystal resistance is high and the voltage drop across the load resistor is a low value; when the impinging x-ray intensities are of high magnitude, the crystal resistance is less and the voltage drop across the load resistor is a higher value.

c. The total d-c and a-c current through the crystal at any given time is also a function of the d-c supply voltage, the value of the series load resistor, the intensity of the x-rays impinging on the crystal at the given time, and the history of the x-ray intensities just previously impinging on the crystal.

d. The graph on the following page approximately shows the voltage appearing across the crystal load resistor for impinging x-ray intensities existing during possible inspection conditions. On the graph, a to b represents the time that x-rays are impinging on the crystal; b to c represents the time during which no x-rays impinge on the crystal. Most of the d-c signal component is removed by capacitor coupling in the amplifier stages, and the amplitude of the a-c component, after amplification and waveshaping, determines whether or not the Hytafill will initiate a reject action. The graph demonstrates that the a-c component amplitudes representing container plus fill material may be too large to accurately represent the height-of-fill, if the immediate previous history is that for no container and no shutter in the beam. For this reason, the Hytafill uses an x-ray shutter to limit the impinging x-ray intensities to magnitudes of the order obtained with an empty container in the beam. The graph demonstrates that the crystal signal must represent the filled container immediately after that container is inserted in the x-ray beam. If the previous history does not disappear immediately, an incorrect reject action will be initiated.

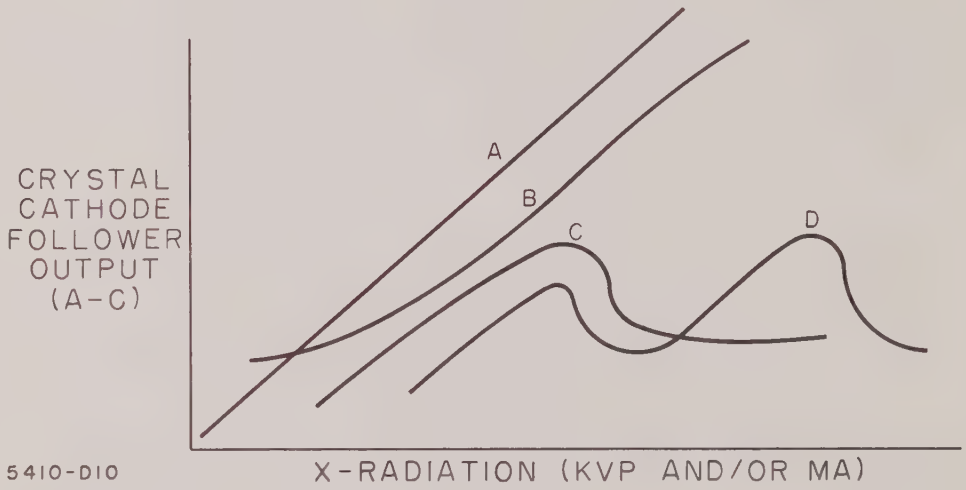
e. The length of time required for the crystal to reach a new state of conduction is dependent on (1) the characteristics of the



CRYSTAL SIGNAL

crystal and (2) the amount of change required.

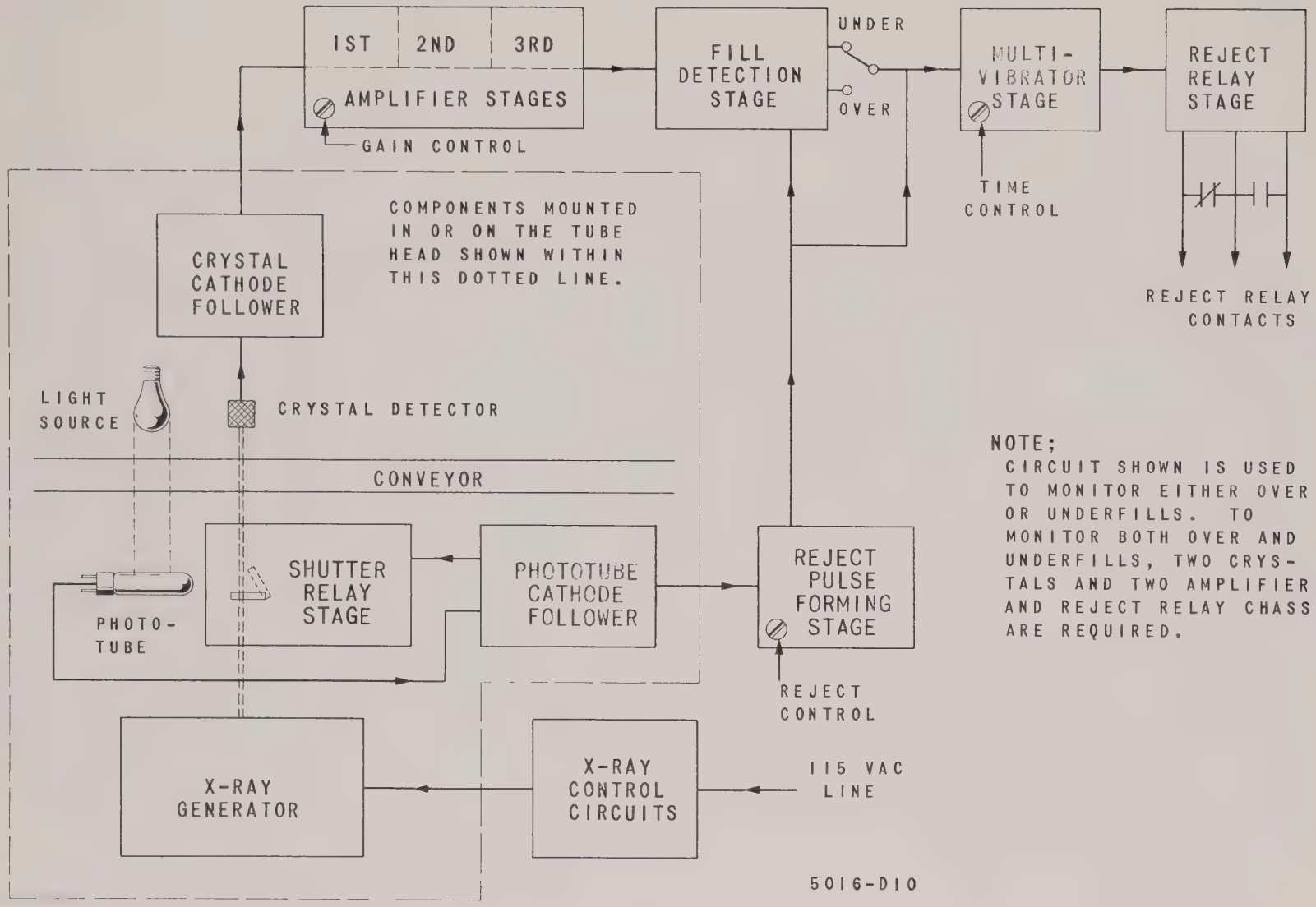
1. Drawing 5410-D10 illustrates four typical crystal output curves. Notice that although all curves show an increase in output voltage as radiation is increased, curves C and D reach a peak value after which output voltage begins to decrease for an increase of radiation. Furthermore, if radiation is increased beyond the value for maximum output voltage the response time of the crystal becomes significantly slower. Slow enough, in fact, that the crystal will



5410-D10

not have reached the new state of conduction until after the gating circuit has signaled the amplifier circuits to begin inspection. Therefore, the amount of radiation striking the crystal during any phase of the inspection cycle must never exceed the value which results in maximum output voltage. If two peaks are evident as shown by curve D, the first peak determines the maximum amount of radiation for operation.

2. The amount of change required is determined by the x-ray absorption of the container wall material and thickness, and fill material. Currently, containers made of commercially available tinplate and filled with material whose density is approximately 1.0 are considered to be within the limits of operation without the shutter. If the container or fill material absorption is greater, the shutter relay and its associated circuits must be used. If in doubt, information for a specific application may be obtained from Product Service, Industrial Section, Milwaukee



NOTE;
CIRCUIT SHOWN IS USED TO MONITOR EITHER OVER OR UNDERFILLS. TO MONITOR BOTH OVER AND UNDERFILLS, TWO CRYSTALS AND TWO AMPLIFIER AND REJECT RELAY CHASSIS ARE REQUIRED.

BLOCK DIAGRAM

H Y T A F I L L

TYPE 2

f. Only four x-ray pulses are shown on the graph for each possible inspection condition because that is the minimum pulses needed for accurate inspection of round containers. Although only one x-ray pulse whose impinging intensity accurately represents the height-of-lift is required to provide reject action, two x-ray pulses may pass through the rounded edges of the container, and a third may pass through the seam in the container. A fourth pulse would then be needed to pass through a truly representative section of the container.

5.03 The Inspection Process

As an aid in understanding the overall inspection process a brief description will be made of one inspection cycle using the Block Diagram, Drawing 5016-D10, as a reference. The operation of the Shutter Relay Stage is included in this discussion, however, if the shutter is not used, all references to it may be ignored since its operation does not affect any other circuits.

a. The Control Circuits supply the operating potentials to the X-Ray Generator which then develops the x-ray beam required for inspection.

b. As the container moves along the conveyor and approaches the inspecting position it will cause the light beam to be blocked from the phototube. The resulting change in phototube output voltage is relayed by the Phototube Cathode Follower Stage to the Shutter Relay Stage, and when the output voltage has reached a predetermined value the shutter will open and allow the full x-ray beam to pass through the container and fill material and strike the crystal. As mentioned previously, the amount of radiation reaching the crystal will be a function of the amount of filtration interposed in the x-ray beam. Therefore, if the fill material is below the acceptable level, the signal from the crystal, because of low absorption of the x-ray beam, will be high; if the fill material is higher than the acceptable level, the signal from the crystal will be low. The signal from the crystal is then fed to the Crystal Cathode Follower Stage and then to the three Amplifier Stages where the desired wave shape and magnitude of the signal are attained.

c. Retracing slightly; a short time after the shutter opens, the output of the phototube reaches another value, preset by the Reject Control, and causes the Reject Pulse Forming Stage to develop a pulse to the Fill Detection Stage. When this stage receives this pulse it "clears", or removes all effects of previous signals. This action is explained in greater detail in the "Electronic Circuits", Section 7.00.

d. At this time the actual inspection begins and the signals received from the crystal through the Amplifier Stages are fed to the Fill Detection Stage. This stage will then either change its state of operation or remain as it is dependent on (a) the magnitude of the signal received from the Amplifier Stage and (b) the initial state of operation as determined by the setting of the Under-Overfill switch. In either case the output voltage of this stage will be high if an unacceptable container is in the inspection position.

e. Remember that all this time the container is moving through the inspection position and will begin unblocking the light beam from the phototube. As soon as the container allows enough light to strike the phototube to cause the output voltage of the Phototube Cathode Follower Stage to reach a predetermined value the x-ray shutter will close and another pulse will be initiated by the Reject Pulse Forming Stage to signal the end of the inspection period. This signal pulse is then combined with the output voltage of the Fill Detection Stage and fed to the Multi-Vibrator Stage. If the combined voltages are high enough the Multi-Vibrator Stage will be triggered and the Reject Relay Stage energized. The length of time that the Reject Relay Stage will operate is controlled by the setting of the Time Control. After the preset time has elapsed the Multi-Vibrator Stage will return to its normal state of operation and the Reject Relay Stage will be cut-off.

f. At this point one inspection cycle has been completed. The state of operation of each stage will remain unchanged until another container enters the inspection position and the Reject Pulse Forming Stage again signals the start of a new inspection cycle.

6.00 X-RAY CONTROL CIRCUITS

6.01 This discussion will refer to the "X-Ray Control Elementary Diagram", Drawing 4474-D41, located in the back of the manual.

6.02 When the line switch (S101) is closed, line voltage is supplied to the line voltage stabilizers (LS501 and LS502), the blower (B501), and the reject relay contacts at TB500-2. A stabilized line voltage is then supplied to the time delay relay (TDRE103), red stand-by light (I101), x-ray tube filament transformer (T201), hour clock (B101), the variac (T101), pre-reading voltmeter (M101), and the power supplies on the electronic chassis.

6.03 After the time delay relay contacts (TDRE103-1) have closed (approximately 30 seconds) closing the x-ray switch (S102A and S102B) then applies power to the green operate light (I102), and x-ray contactor (RE101). (It should be noted at this time that during operation the x-ray switch is normally left closed and the time delay will close the x-ray circuit after the electronic circuits have had time to warm up.) The x-ray contactor then applies power to the high voltage transformer (T202) which in turn causes the x-ray tube (V201) to conduct and produce x-rays.

6.04 The intensity and penetrating power of the x-rays produced are adjusted by means of the Filament Control (R101) and the Variac (T101). Their settings will be explained more fully in the "Operational Tests and Adjustments", Section 10.00. Notice that the ground return of the cathode, or filament, side of the x-ray tube is through one-half of the high voltage transformer secondary (T202), the ma meter (M102), rheostat (R105) and resistor(R106). Rheostat R105 is mechanically coupled to the Filament Control (R101) so that, for a given ma setting, the resistance of R105 and R106 will be such to develop an IR drop of approximately +105 volts from pin 1 of the filament stabilizing relay (RE102) to ground. The 2 mfd condenser (C102) averages out the voltage pulses developed across R105 and R106 by the pulsating tube current. The other side of the stabilizing relay, pin 3, is also connected to a +105 volt potential from a regulated d-c power supply on the electronic chassis. Since the stabilizing relay (RE102) is a microampere sensitive device a very small potential difference across its coil will cause its contacts (RE102-1) to be actuated. When its contacts are closed, R103 in series with the filament transformer primary (T201) is shorted out causing the filament heating current to increase until the voltage drop across R105 and R106 again reaches +105 volts. In actual operation, the relay contacts open and close once during each cycle of filament transformer supply voltage. If x-ray tube current decreases, the contacts are closed for a longer portion of the cycle, providing a greater average filament heating current to maintain x-ray tube current at the desired value. If contacts RE102-1 should fail to open or close the ma will be too high or low and cannot be adjusted over its normal range.

6.05 The ma stabilizer circuit was incorporated in the unit primarily to provide a means of compensating for changes in characteristics of the x-ray tube. Any changes that may occur will usually result in a drift of ma from the time the unit is turned on until it is fully warmed up. However, in many cases this drift may not occur or, if it does, it may be too small to affect the operation of the unit. This philosophy should be kept in mind and if conditions permit, it

may be desirable to remove the stabilizing relay RE102. A relay should still be available should a future tube change require its replacement.

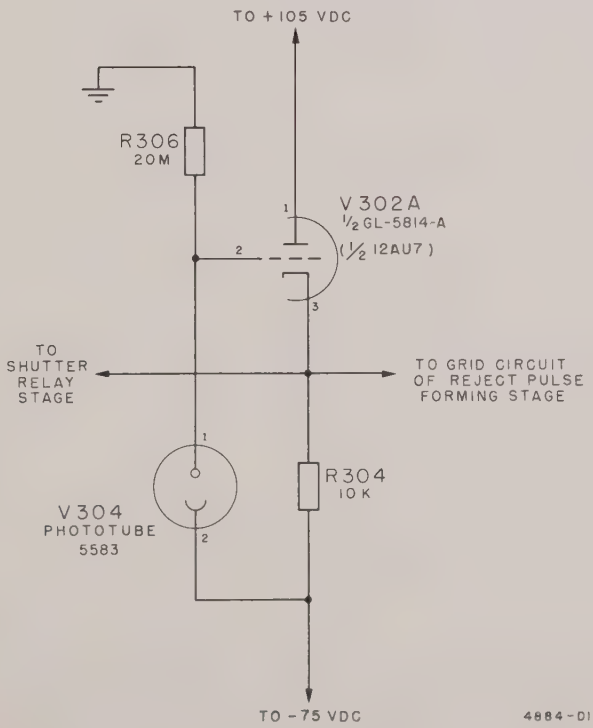
7.00 ELECTRONIC CIRCUITS

7.01 This discussion will refer to the individual schematic diagrams included in the text and the "Hytafill Electronic Schematic", Drawing 4480-D51, in the back of this manual. To quickly locate component parts on this schematic look up the circuit symbol in the "Component Parts List and Description", Section 14.00, and note the co-ordinates of the component as located on the drawings. A brief description of the circuit function of each component may also be found in this section.

7.02 This discussion of the function of the electronic circuits purposely leaves the operation of the test circuits to the end of the discussion, wherever practical. While reading the earlier text material, assume test switches S701 and S702 to be in the normally closed position and test switch S703 to be in the normally open position.

7.03 Phototube Gating Circuit

a. The function of this circuit is to develop a voltage or signal to indicate the time that a container is in the inspection position. The output voltage of this stage is then applied to both the shutter relay stage and the reject pulse forming stage to begin and end the inspection process at the proper time.



b. The gating circuit consists of a phototube (V304) and a cathode follower stage, which uses a half section of a GL5814A (12AU7) vacuum tube (V302A). In conjunction with this circuit, a light source (I301) is used to provide the light beam for the phototube and is physically mounted on the opposite side of the conveyor and arranged so that the light and x-ray beam are vertically parallel. The light beam is then focused to just cover the cathode surface of the phototube.

c. Before a container enters the inspection position, the full light beam is striking the phototube and its conduction will be at a maximum and the voltage drop across it a minimum. This action will then hold the grid of V302A more negative reducing its conduction. Since V302A and R304 form a voltage divider from +105 vdc to -75 vdc the voltage drop across R304 will be very small resulting in a large negative potential, as measured with respect to ground, at the output of this stage. This voltage will usually be about 30 to 35 volts, negative, depending on the condition of the phototube.

d. Now, as a container moves into the inspection position, blocking the light beam from the phototube cathode, conduction of the phototube (V304) decreases, conduction of V302A increases, and the voltage drop across R304 increases. The resulting output potential, as measured with respect to ground, then decreases (becomes less negative) until finally when the entire light beam is blocked the output potential will be slightly positive. For proper operation it is essential that a positive voltage is obtained regardless of how small it might be.

e. Another important factor is that the sensitivity of the phototube and focusing of the light source must be such that a minimum of -9 volts is obtained at the output of this stage when two containers are in the inspection position and spaced 1/8" apart. The reasons for these requirements will be explained more fully in the discussion of the circuit in which it is used.

f. The circuits dependent on the proper gating circuit output potentials are (a) shutter relay stage and (b) reject pulse forming stage.

7.04 Shutter Relay Stage

This stage may or may not be used depending on the type of containers to undergo inspection. If it is not used, the shutter should be blocked in the closed position and V303 removed. Operation, or lack of operation, will in no way affect the operation of any other circuits.

a. When required, the function of the shutter relay stage is to insure that the shutter is open only when the container is in the inspection position.

b. The shutter relay is mounted in the cathode follower housing on the tube head and consists of a twin-triode (V303), directly coupled amplifier circuit that has a relay coil in series with each plate. The relay coils are mounted as shown on Drawing

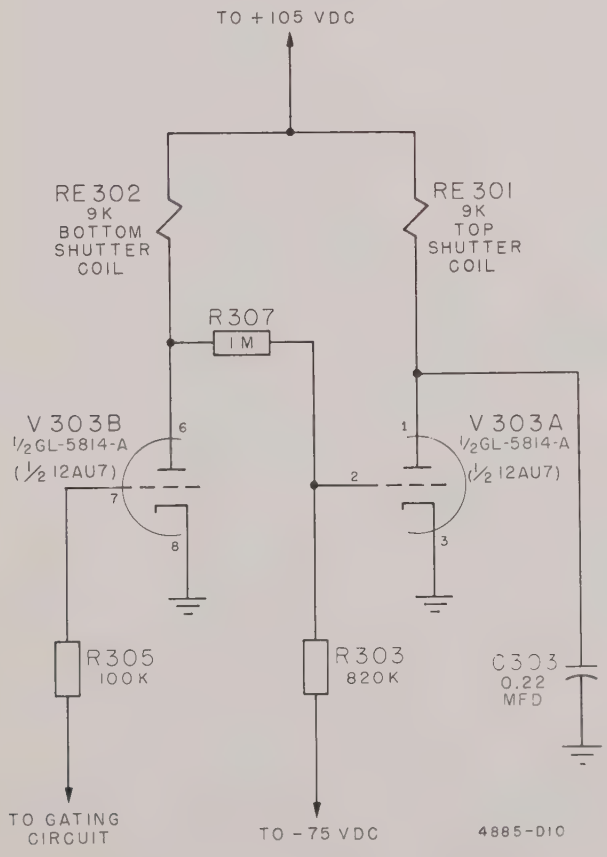
3591-D25 with an "L" shaped armature hinged between the horizontally stacked relay coils so that when the front relay coil is energized the short arm of the "L" (the x-ray shutter) will cover the x-ray port slit. When the rear relay coil is energized the x-ray shutter will be pulled clear of the x-ray port.

c. So that the x-ray shutter will be open only during the inspection period, the shutter relay stage is designed to have two stable states of operation.

(1) V303A is conducting and V303B is not conducting; therefore, the top shutter coil is energized and shutter is closed.

(2) V303A is not conducting and V303B is conducting; therefore, the bottom shutter coil is energized and the shutter is open.

d. Before the container moves into the inspection position the gating circuit output potential is high (approximately -35 volts) and since the cathode of V303B is connected to ground the grid-cathode voltage of V303B will be the same as the gating circuit output voltage; more than enough to keep V303B cut-off. However, the voltage divider consisting of RE302, R307 and R303 is arranged so that when V303B is cut-off the voltage applied to the grid (pin 2) of V303A is essentially zero allowing this stage to conduct very heavily energizing the rear shutter coil (RE301) which closes the x-ray shutter. This condition now corresponds to (1) listed above.



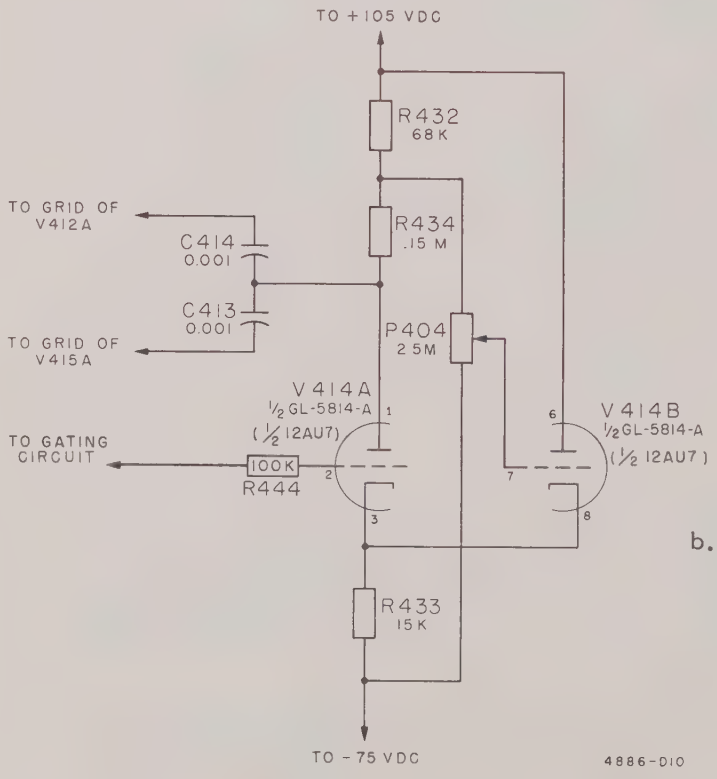
e. As the container moves into the inspection position the gating circuit output potential decreases, becomes less negative, changing the grid-cathode voltage of V303B. As this voltage becomes less negative conduction through V303B increases, causing the plate voltage at pin 6 to decrease and consequently the grid voltage of V303A

to become more negative and decrease the conduction through V303A. Finally, when the gating circuit output potential reaches approximately -5 volts V303A will allow the front shutter coil (RE302) to release the shutter while at the same time V303B will cause the bottom shutter coil to pull the shutter away from the x-ray port.

f. Therefore, it can be seen that whenever the gating circuit output potential is more negative than -5 volts the x-ray shutter will be closed and whenever it is less negative than -5 volts the x-ray shutter will be open.

7.05 Reject Pulse Forming Stage

a. The purpose of the reject pulse forming stage is to produce two voltage pulses which will be used by following stages; a negative pulse when the container enters the inspection position and a positive pulse when the container leaves the inspection position. Only the method of, and reasons for, producing the pulses will be described in this section. The final purpose will be fully explained in the discussion of the fill detection stage and reject multi-vibrator stage.



b. Since one pulse is required when the container enters the inspection position and another pulse when the container leaves, this stage is also designed to have two states of operation. However, since the output of this stage is fed through a capacitor only a change in operating states will affect the following stages.

c. Before beginning, two facts should be noted and observed during this discussion.

(1) The grid-cathode bias of V414A is determined by (a) the gating circuit output potential and (b) the voltage developed across R433.

(2) The grid-cathode bias of V414B is determined by (a) the potential at the center tap of P404 and (b) the voltage developed across R433.

d. With this in mind let us assume there is no container in the inspection position and the full light beam is striking the phototube. V414A will then be cut-off and V414B will be conducting very heavily. As a container enters the inspection position and begins to block the light beam the grid voltage on V414A becomes less negative and begins to conduct. Conduction of V414A will then cause the IR drop across R434 and R432 to increase, which reduces the grid voltage of V414B reducing its conduction. Because of the circuit components used conduction will be much greater through V414B than through V414A. Therefore, as V414B conduction decreases there will be a resultant sharp decrease in the IR drop across R433 abruptly changing the grid to cathode voltage of V414A. This change is then reflected as a negative pulse at the plate of V414A which is then fed through C413 to the grid of V412A, assuring that it will be non-conducting at the start of the inspection period.

e. As the container leaves the inspection position the gating circuit output potential becomes more negative and when it reaches approximately -5 volts, conduction of V414A will have decreased to the point where the IR drop across R434 and R432 will cause V414B to increase conduction. As conduction through V414B increases, the IR drop across R433 increases, resulting in cut-off of V414A. The abrupt rise of V414A plate voltage as V414A is cut-off is transmitted as a positive pulse through C413 to the grid of V415A, reject multivibrator tube, that is normally cut off. If all other conditions are favorable this pulse aids in triggering the reject multivibrator stage, initiating a reject action.

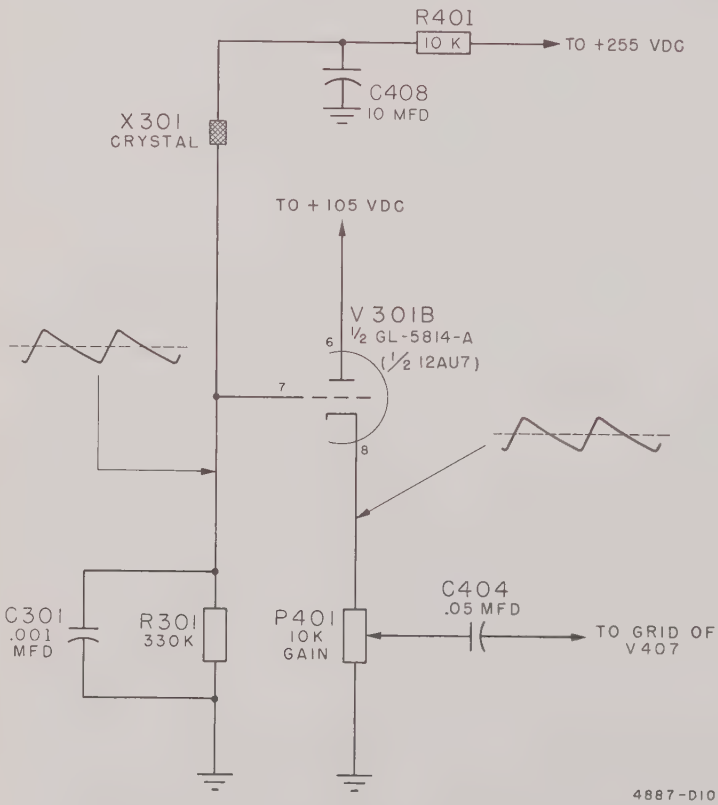
f. This circuit has been designed so that it will develop a positive pulse when the gating circuit output potential is approximately -5 volts as a container leaves the inspection position and a negative pulse when the gating circuit output potential is approximately -1-1/2 volts as a container enters the inspection position. However, by adjusting for either of these conditions the remaining condition is automatically set up. The circuit is adjusted by means of P404 and when properly adjusted the grid-

cathode bias of V414B will be slightly positive as the container enters the inspection position. Also, when properly adjusted the circuit operation is virtually immune to noise voltages that may be developed in the interconnection wiring between the phototube and electronic chassis.

g. At this point the pulses developed by the reject pulse forming stage will be left to be later tied into the remaining circuits when the pulses are required. The discussion will be continued beginning at the crystal.

7.06 Crystal Signal Cathode Follower Stage

The crystal signal is developed as a result of a change in the resistance of the crystal as x-rays strike it. As the x-ray intensity increases, the resistance of the crystal decreases and the voltage drop across R301 increases. Also, since the x-ray pulses are generated at the rate of 60 per second a 60 cycle signal will appear at the grid (pin 7) of V301B. Since the crystal signal must be transmitted from the cathode follower chassis, on the tube head, to the control, a distance of up to 50 feet, a cathode follower stage V301B is used to permit the use of a relatively small load resistance for the shielded cable which transmits the signal. The amplitude of any high frequency noise voltages appearing at the input of the amplifier is thereby reduced because of the low resistance of the Gain Control (P401) with respect to the impedance of the associated cable and circuits. In this case the cathode resistor for V301B, Gain Control (P401), is mounted on the amplifier chassis in the control and is adjusted to provide the required signal input to the amplifier stages.

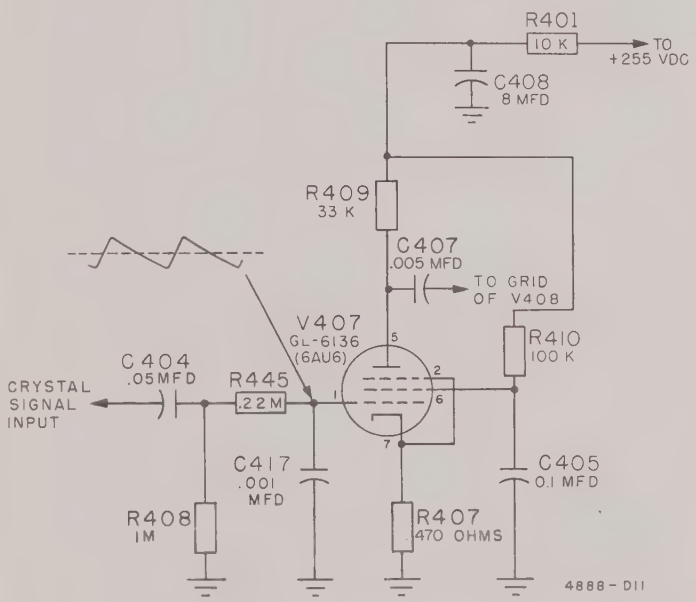


7.07 Signal Amplifier Stages

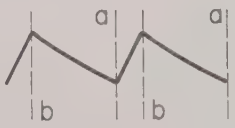
The signal amplifier stages consist of three amplifier stages which will be discussed individually.

a. First Amplifier Stage

(1) The V407 stage is a low gain, sharp cut-off amplifier. Since only the a-c portion of the signal is representative of the amount of absorption experienced by the x-ray beam, the d-c portion is removed by the coupling capacitor (C404) in the input of the first amplifier.



(2) Except for the normal 180 degree phase shift of a signal passing through an amplifier stage the waveform of the crystal signal appearing at the output of V407 is essentially the same as at the input as shown below. Notice that in the plate circuit the voltage change from a to b occurs in less time than the voltage change from b to a. This factor will be utilized in the next amplifier stage.



GRID V407
A

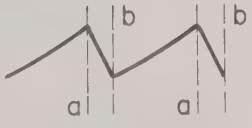


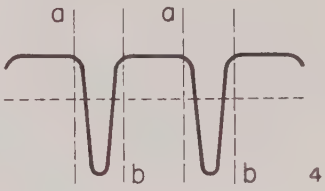
PLATE V407
B

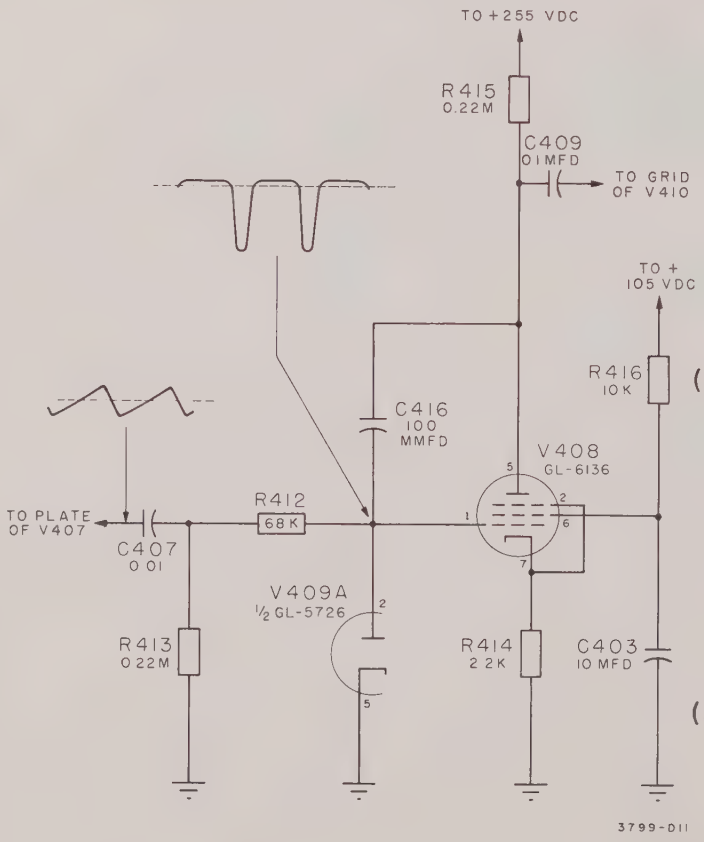
4889-DIOA

b. Second Amplifier Stage

(1) The input circuit of the V408 stage changes the waveform of the crystal signal (differentiates it) before it is applied to the grid of V408. Because a small capacitance (C407)

has been selected and because the charging current is relatively high, C407 will respond very rapidly to changes in plate voltage of V407. As the plate voltage of V407 reaches a maximum occuring at point "a", on the above drawing, the voltage developed across C407 is nearly the same as the plate voltage of V407. When the plate voltage of V407 decreases from "a" to "b",





C407 discharges through R413 and since the negative change of plate voltage of V407 occurs during a very short time interval the V407 plate voltage change from "a" to "b" will cause a sharp negative pulse to appear across R413 and therefore between the grid and cathode of V408.

(2) Since the time interval required for the plate voltage of V407 to change from "b" to "a" is much longer the positive pulse will be much broader and of much lower magnitude than with the conditions just described.

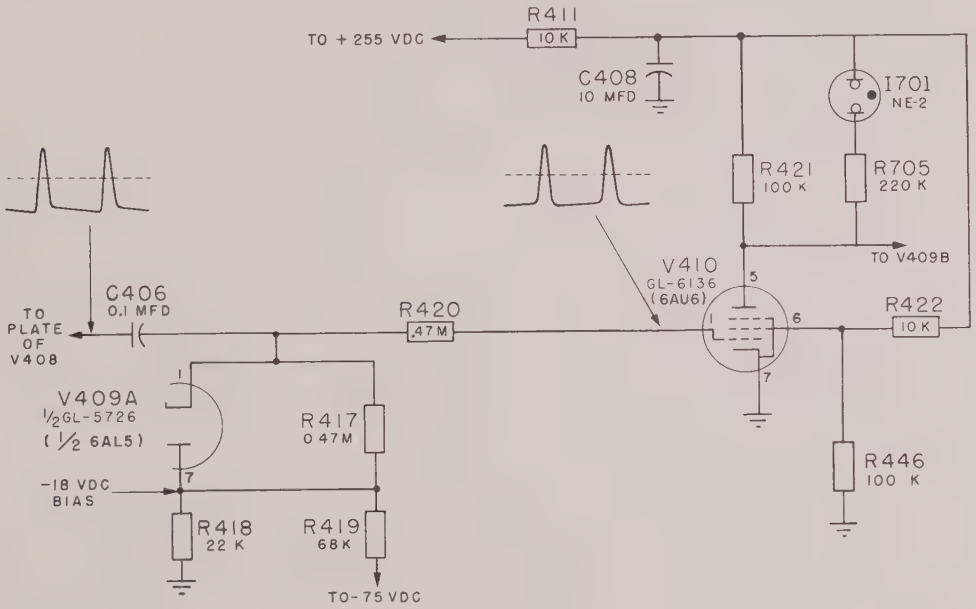
(3) The effect of the input circuit is to cause the signal from the plate of V407 to appear as an amplified negative pulse to the grid of V408. The pulses are then further amplified and appear as a positive pulse at the plate of V408.

c. Third Amplifier Stage

(1) Because of the relatively large value of the coupling capacitor (C409) the positive signal pulses from V408 appear in the grid circuit without significant change in waveform.

(2) With x-ray off and no crystal signal the grid-cathode of V410 is held at approximately -18 volts by the network consisting of R418 and R419. When the signal pulse from V408 appears on the grid of V410 the immediate effect is that the plate potential of V410 will become less positive during the time that the signal pulse in the grid circuit exceeds the cut-off value and V410 conducts.

(3) If the x-ray tube current and T202 primary voltage are properly adjusted, signals representing container plus fill



material will not cause the third amplifier to conduct. Signals representing container only, however, will cause the third amplifier to conduct.

(4) Depending on the type of container being inspected, the absorption of the x-ray beam shutter may approximate the absorption of an empty container. Under these conditions V410 conduction will cause the plate potential to become sufficiently less positive to cause I701, the neon lamp on the test panel, to glow when there is no container in the inspection position. I701 will also glow each time there is an underfilled container in the inspection position. However, depending on the speed with which the container moves through the inspection position, the glow may or may not have a practical value.

(5) During actual production operation, the condition of I701 should not be relied on as an absolute indication of the operation of the preceding circuits. I701 must glow, however, if an empty container is placed at rest in the inspection position and completely blocking the light beam. The purpose of I701 is explained more fully in paragraph 7.10b "Test Circuits".

7.08 Fill Detection Stage

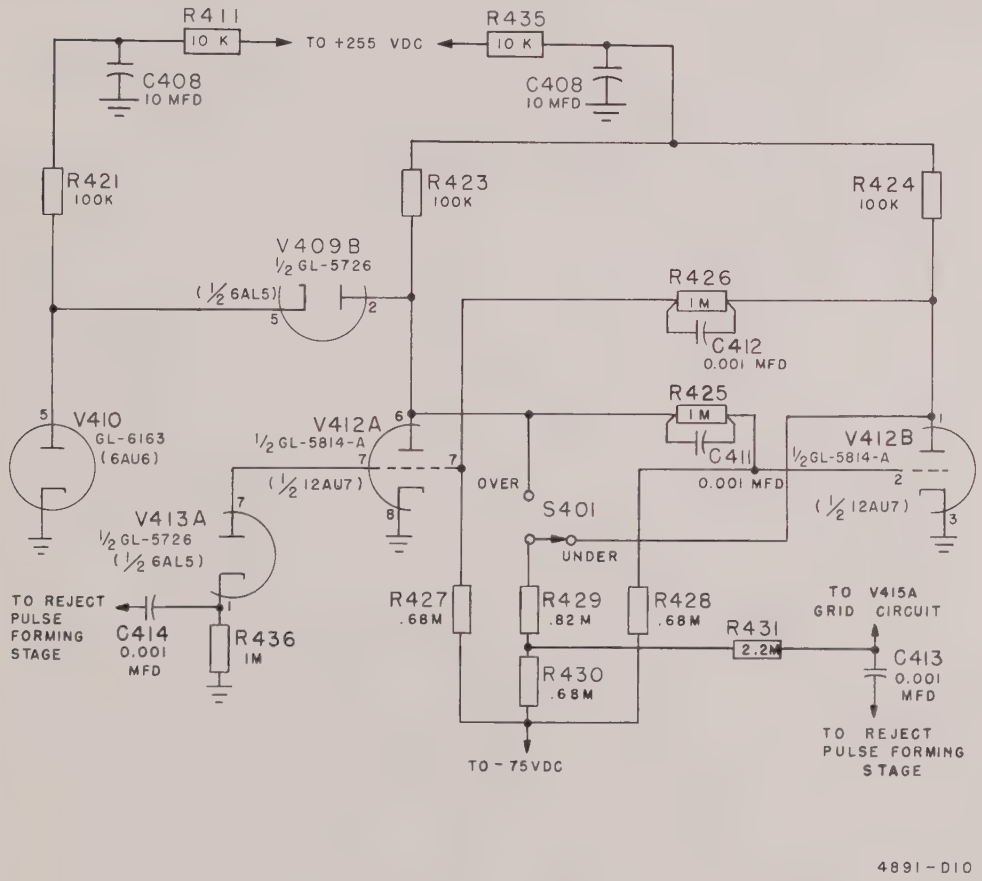
a. The fill detection stage (V412) is a two conduction state trigger circuit which may be triggered by the conduction of the third amplifier stage. The stage consists of two triode sections of a GL5814A tube with voltage divider networks (R425 and R328; R426 and R427) connected from each triode plate to the other triode grid. In this type of circuit when one triode is conducting the other one must be cut-off. However, since both triode sections have identical circuits the tolerances of the circuit components will determine which section will normally conduct and which will be cut-off. Also, once it has started, the state of conduction of this stage will not change unless a voltage of the correct phase is introduced into the circuit.

b. It is at this point that the negative signal pulse developed by the reject pulse forming stage will be used. As stated in the discussion of that stage a negative pulse is developed as a container enters the inspection position. This pulse is then fed into the grid circuit of V412A, through C414 and V413A, to assure that V412A will always be cut-off at the start of the inspection period.

c. Let us then assume that a container is entering the inspection position and V412A is cut-off. When the third amplifier (V410) conducts, its plate voltage becomes less positive and since V409B is also connected to this point and the plate of V412A, the cathode of V409B will be negative with respect to its plate and it too will begin to conduct. The path of conduction is through V409B, R423, the power supply, and back through V410. The voltage drop across R423, caused by this conduction, reduces the plate voltage of V412A to a value practically the same as the voltage on the plate of V410. Because C411 cannot change its condition of charge instantly, most of the negative voltage change at the plate of V412A will appear across R428 causing the grid (pin 2) to cut-off conduction of V412B. When this occurs the plate voltage of V412B increases and since C412 cannot change its charge instantly the grid voltage of V412A will rise above cut-off, allowing V412A to start conducting. This

sequence will then continue until V412B is cut-off and V412A is in full conduction.

d. A single-pole, double throw switch, S401, is wired so that one contact (marked "Under") is connected to the plate of V412B and the other contact (marked "Over") is connected to the plate of V412A. The fact that the plate voltage of a tube which is cut-off is higher than that of a tube which is conducting explains how the operation of the fill detection stage and the position of

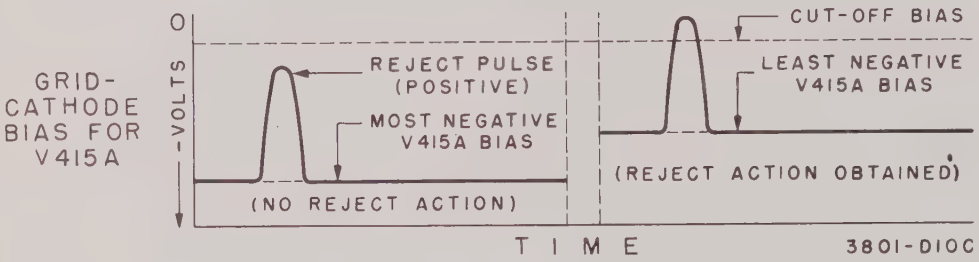


the Over-Under switch can help determine whether or not a reject action will be initiated.

e. In the discussion above, a signal was received from V410, indicating an underfilled container, resulting in V412A conducting and V412B cut-off. Therefore, the plate voltage of V412B will be high and with the switch (S401) set for "Under" the voltage fed to the grid of V415A, taken from the junction of R429 and R430, will also be high. Then, when this voltage is com-

bined with the positive pulse developed by the reject pulse forming stage as the container leaves the inspection position, the combination will be sufficient to trigger the reject multivibrator stage. This action is demonstrated on the following page.

f. If the switch (S401) is connected to "Over" the absence of a signal from V410, indicating an overfilled container, will cause V412A to remain cut-off and the voltage to the grid of V415A will again be high enough to cause a reject action. However, should a signal enter the V412 stage the state of conduction will



be changed, the plate voltage of V412A will be low and the voltage to the grid of V415A will be too low to cause a reject action.

g. In short, the negative pulse from the reject pulse forming stage causes V412A to be cut-off at the beginning of the inspection period. That is, it causes all previous signals received by V412 to be wiped out.

h. Next, the V412 stage will receive, operate accordingly, and hold any signals received during the inspection period. Then, as the container leaves the inspection position the positive pulse from the reject pulse forming stage will be combined with the output voltage of V412 and, if required, signal the reject multivibrator for a reject action.

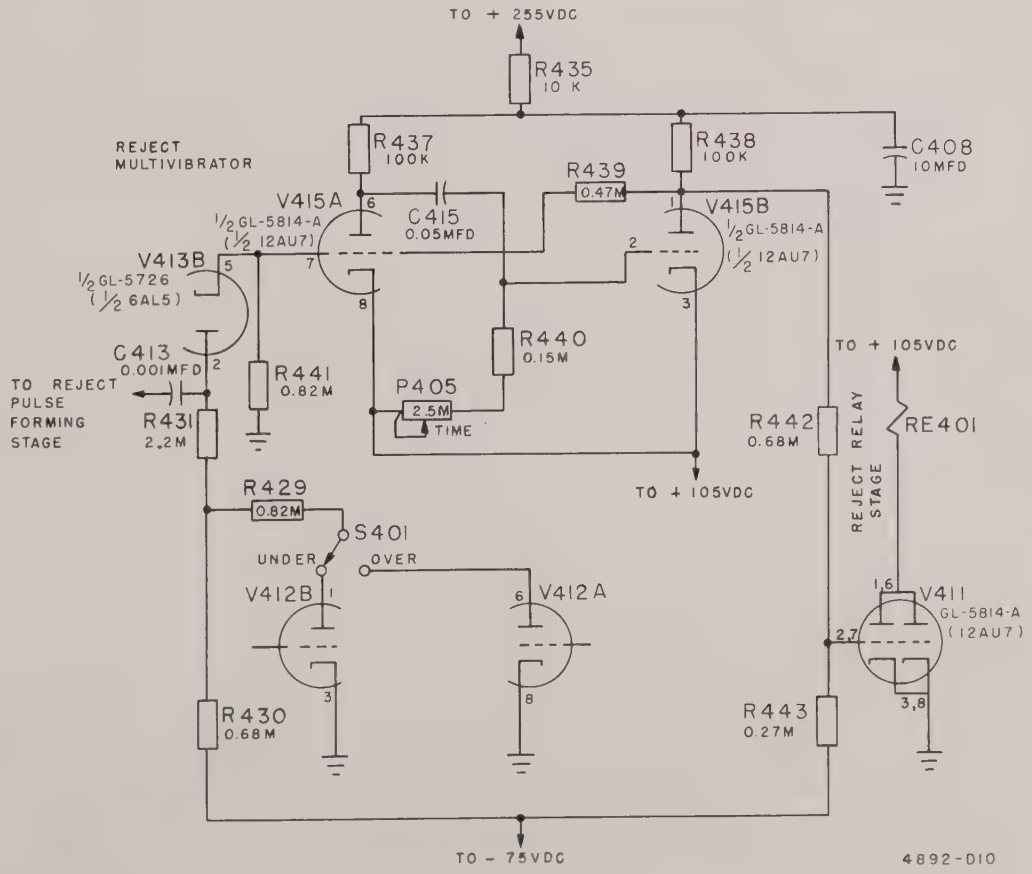
7.09 Multivibrator Stage and Reject Relay Stage

a. The multivibrator and reject relay stages are designed to actuate the reject relay for only that time required to reject the improperly filled container. From the discussion given in Section 7.08, it should be understood that the multivibrator is triggered as the container leaves the inspection position, if the x-ray beam at the level of inspection has seen container only and if the amplifier is set to monitor underfills; or, if the x-ray beam has seen container plus fill material and the amplifier is set to monitor overfills.

b. The multivibrator is a one cycle trigger circuit which is a two conduction state circuit that can be triggered from its normal state of conduction to a second state of conduction and, after a controlled interval of time, automatically return to its normal state of conduction.

c. Bearing the above facts in mind, the operation can be explained as follows:

V415B is normally conducting. The reject relay amplifier, V416, is normally cut-off as a result of the voltage divider network in its grid circuit and the low voltage at the plate of V415B. V415A is normally cut-off because its grid is held below cut-off by the voltage dividing network consisting of R439 and R441. When the multivibrator is triggered, V415A conducts and V415B is cut-off. As a result of this action, V415B plate voltage becomes more positive and the grid voltage for V416 must also become more positive. This change in V416 grid voltage is sufficient to cause V416



to conduct and energize the reject relay. The reject relay will remain energized as long as V415B is non-conducting. The time during which V415B will be non-conducting will be determined by the setting of the Time Control (P405)

d. When the signal to V415A causes it to conduct, its plate voltage will become less positive. However, C415 has already been charged to a higher value and will have to discharge to the lower voltage now on the plate of V415A. R440 and P405 are in the discharging current path for C415 and since this current is in such a direction to develop a negative voltage at the grid of V415B the discharge of C415 will cause the grid of V415B to become sufficiently negative to cause V415B to be cut-off and the reject relay to be energized. However, since the discharging current decreases with time, the negative voltage at the grid of V415B also decreases with time until it reaches a value which will permit V415B to again conduct and the reject relay to be de-energized.

e. Then, because of the decrease in plate potential that occurs when V415B conducts, the voltage dividing network of R439 and R441 causes the grid of V415A to become highly negative with respect to its cathode, causing V415A to become non-conducting. The multivibrator has now returned to its normal state, awaiting another positive pulse from the reject pulse forming stage that is combined with the least negative V415A cut-off grid bias as determined by the state of conduction of the fill detection stage and the position of S401.

f. By varying the portion of the Time Control, P405, that is in the C415 discharge current path, the magnitude of the C415 discharging current, and therefore, the time required for C415 to change its condition of charge may be varied. In this manner the length of time that V415B is cut-off and the length of time that the reject action may be sustained is varied. The start of the reject action always occurs at the instant the container moves out of the inspection position. The Time Control permits the reject action to be sustained long enough to physically reject only the unacceptable container.

7.10 Test Circuits (Refer to Drawing 4480-D51)

The components of the test circuits are mounted on the TEST PANEL on the left side of the amplifier panel. On the front of the panel are mounted S701 and I701, marked CRYSTAL, S702 and S703 marked PHOTOTUBE. Behind the panel are mounted R701 through R705. Spring return switches are used to make certain the circuits are left

connected for normal operation. The use of the test switches is incorporated, whenever practical in the "Amplifier Adjustments" and the "Trouble Shooting Chart".

a. Gating Circuits (PHOTOTUBE)

(1) In its normal position switch S702 connects the output of the phototube cathode follower to the reject pulse forming stage. When S702 is in the test position the grid of V414A is connected to the -75 volt supply through R444 and R704. This simulates the condition of no container in the inspection position and the phototube receiving the full light beam. Since the phototube cathode follower is disconnected when S702 is in the test position the operation of the reject pulse forming stage is no longer dependent on the operation of I301, phototube light source, V304 phototube, or V302, cathode follower stage.

(2) While holding S702 in the test position, pressing pushbutton S703 connects a voltage divider consisting of R703 and R704 from -75 volts to ground. When S703 is depressed the potential at the grid of V414A is approximately -1.5 volts. The reject pulse forming stage has been designed to operate at -5 volts as a container leaves the inspection position and at approximately -1.5 volts as a container enters the inspection position. Therefore, each time S702 is held in the test position and S703 is pressed, the condition of a container entering the inspection position is simulated and a gating signal is supplied to the reject pulse forming stage.

(3) With x-ray OFF, the Underfill-Overfill switch set for Overfill, S702 in the test position, rapidly pressing S703 will simulate containers passing through the inspection position and a reject action should be initiated each time S703 is released.

b. Amplifier Circuits (CRYSTAL)

(1) In its normal position, switch S701 connects part of the signal developed across P401, GAIN control, to the first amplifier stage. When S701 is in the test position a fixed signal of approximately 0.1 volt a-c is picked off the voltage divider consisting of R701 and R702 connected across one half of the 6.3 volt filament transformer. This represents the minimum signal required by the amplifier to initiate a reject action.

(2) Since the crystal cathode follower is disconnected by this action the operation of the amplifier stages is no longer dependent on the operation of the x-ray generator, X301 or X302, crystals, or V301A or V301B, crystal cathode follower. Also, since the Gain control is disconnected, the setting will not have to be disturbed to check the amplifier.

(3) The neon lamp, I701, is connected in the plate circuit of V410 and will glow whenever V410 is conducting. If the three amplifiers are functioning properly the magnitude of the test signal, injected when S701 is held in the test position, will allow sufficient conduction of V410 to cause I701 to glow. Since the test signal represents the minimum signal required by the amplifier to initiate a reject action it follows that the crystal signal fed to the amplifier when an underfilled container is in the inspection position must also be of sufficient magnitude to cause I701 to glow.

8.00 OUTLINE OF HYTAFILL OPERATION

8.01 A dual channel Hytafill gage operates in the same manner as the single channel gage unit with the exception that two crystals and two electronic chassis are used. The cathode follower stage, V301A transmits the signal from one of the two crystal detectors to the second amplifier and reject relay chassis. In the following discussion a dual channel gage is assumed; for a single channel gage, ignore any references to which ever condition of fill is not being monitored.

8.02 The two crystals in the detector housing must be so spaced vertically that the lower crystal intercepts the x-ray at the minimum fill level and the upper crystal intercepts the x-ray at the maximum fill level.

8.03 Signals from the upper crystal detector are fed into the amplifier that is set to monitor over fills (S401 on OVER); signals from the lower crystal detector are fed into the amplifier that is set to monitor underfills (S401 on UNDER).

8.04 When a container enters the inspection position, the light on the phototube is blocked, causing the gating output potential to increase from approximately -35 volts to a positive voltage. As a result, the following actions occur:

a. The x-ray shutter (if used) opens.

b. The reject pulse forming stage in each amplifier develops a negative pulse which assures that the V412A section of the fill detection stage is cut-off as the container starts to undergo inspection.

8.05 While a container is in the inspection position:

a. If the container has an acceptable height-of-fill:

(1) The signal from the lower crystal is not of sufficient amplitude to allow conduction of the third amplifier; the fill detection circuit in the associated amplifier will not be triggered, and the grid-cathode potential of V415A will remain at its most negative cut-off value.

(2) The signal from the upper crystal is of sufficient amplitude to allow conduction of the third amplifier; the fill detection circuit will be triggered, and the grid-cathode bias of V415A will change to its most negative cut-off value.

b. If the container height-of-fill is unacceptably low:

(1) The signal from the lower crystal detector will be of sufficient amplitude to allow conduction of the third amplifier; the fill detection circuit will be triggered and the grid-cathode bias of V415A will change to its least negative cut-off value.

(2) The signal from the upper crystal is of sufficient amplitude to allow conduction of the third amplifier in the associated amplifier; the fill detection circuit will be triggered, and the grid-cathode bias of V415A will change to its most negative cut-off value.

c. If the container height-of-fill is unacceptably high:

(1) The signal from the lower crystal will not be of sufficient amplitude to allow conduction of the third amplifier in the associated amplifier; the fill detection circuit will not be triggered, and the grid-cathode bias of V415A will remain at its most negative cut-off value.

(2) The signal from the upper crystal will not be of sufficient amplitude to allow conduction of the third amplifier in the associated amplifier; the fill detection circuit will not be triggered, and the grid bias of V415A will remain at its least negative cut-off value.

8.06 As the container leaves the inspection position, the gating output potential decreases from a positive voltage to approximately -35 volts or -15 volts, depending upon the spacing between containers. As a result, the following actions occur:

a. The shutter (if used) closes.

b. The reject pulse forming stage in each amplifier develops a positive pulse which is impressed across the grid-cathode of V415A, but a reject action will be obtained only if the state of conduction of the fill detection stage and the setting of the Over-Under fill switch, S401, are such that the least negative V415A grid-cathode bias exists.

(1) If the container has an acceptable height-of-fill:

a) The amplifier which received its signal from the lower crystal will not initiate a reject action.

b) The amplifier which received its signal from the upper crystal will not initiate a reject action.

(2) If the container's height-of-fill is unacceptably low:

a) The amplifier receiving its signal from the lower crystal will initiate a reject action.

b) The amplifier receiving its signal from the upper crystal will not initiate a reject action.

(3) If the container's height-of-fill is unacceptably high:

a) The amplifier receiving its signal from the lower crystal will not initiate a reject action.

b) The amplifier receiving its signal from the upper crystal will initiate a reject action.

9.00 PRELIMINARY TESTS AND ADJUSTMENTS

9.01 After the mechanical and electrical installation is completed as described in Section 4.00, the unit is ready for operational adjustments. These initial adjustments, up to the final operational check and the establishment of the inspection level, can be performed without any interference to any production use to which the conveyor is being utilized. When such production is in process, the tube head

must be tilted back on its hinge, allowing access to the face of the tube head.

9.02 Initial Application of Power

The purpose of this section is to guide the installer in first applying power to the unit.

a. First, assure yourself that operation of the unit, in its present condition of assembly will not cause any exposure to personnel working in adjacent areas. In operation, x-rays emerge at the port adjacent to the shutter mechanism. With the housing cover and hood off, this beam is relatively wide, spreading out with increased distance from the head--even if the shutter remains in its blocking position. If any doubt exists as to the safety of adjacent personnel, place a piece of 1/8" lead over the port.

b. Set the Variac, T101, the Filament Control, R101, and all other control potentiometers fully counterclockwise (CCW).

c. Apply power to the unit. The red panel light and all vacuum tubes within the electronic chassis should light. Tubes V403 (OB2) and V404 (OB2) on each amplifier chassis should have a blue glow. Tube V405 (OA2) on each chassis should have a reddish glow. Failure to do so indicates a faulty tube or excessive load on the power supplies due to a component failure or miswiring.

d. Wait approximately 1/2 minute for time delay relay TDRE501 to operate, then turn the Variac, T101, clockwise until the panel voltmeter reads 60 volts. Turn the x-ray switch ON and turn the Filament Control clockwise until 2 ma is indicated on the panel milliammeter. The green light on the panel should light before 2 ma is reached. The milliammeter should be stable to with ±.2 ma. If not, trouble is present. (Refer to the trouble shooting section.)

e. Allow the unit to operate for 10 minutes or so, during which time frequently check the ma stability and the tube head for indications of internal arcing (placing the ear close to the side of the tube head). If either difficulty occurs, refer to the trouble shooting section.

f. Check that cooling water (where used) is flowing through the tube head cooling coils. The desired water flow can be set later, after the unit has been operated sufficiently to become warm.

g. After the prescribed 10 minutes of operation shut the unit OFF and proceed with the next step.

9.03 X-Ray Port Position

The position of the x-ray tube and the phototube base chassis, with the x-ray port, has been set at the factory using a special alignment jig. Due to the extreme importance of these settings on overall operation and due to the possibility of changes occurring during shipment, it is imperative that they be carefully checked.

a. Place a 12 or 15 inch ruler across the open face of the housing. The level of the ruler should be such that the x-ray beam will pass through, or just above, the scale markings. The ruler may be rested on screws partially engaged in the tapped cover mounting holes.

b. Determine the center of the housing on the ruler. To avoid errors, it may be found desirable to tape the ruler to the housing to prevent accidental movement and to clearly mark, on the ruler, the center point.

c. Temporarily block the shutter in the open position so the outline of the x-ray port may be more easily seen on the fluorescent probe with low values of kvp and ma. If it is intended to use the shutter relay stage and V303 is installed, the shutter may be held in the open position by slipping an empty vacuum tube carton over the phototube.

d. Energize the unit, applying x-ray at 60 primary volts and 2 ma. TAKE SPECIAL CARE, DURING THIS AND SUBSEQUENT TESTS, TO KEEP YOUR HANDS, ARMS, AND BODY OUT OF THE DIRECT X-RAY BEAM. WORK FROM BELOW OR TO THE SIDE OF THE X-RAY PORT.

e. Place the fluorescent screen probe, supplied with the unit, at the center mark for the housing and observe the position of the primary beam. If the fluorescence of the screen in the primary beam is difficult to see, shield it from adjacent light so as to make it more visible. Make certain that the shutter is clear of the port.

f. If the center of the primary beam, as evidenced on the fluorescent probe, is more than 1/32" off the center mark of the ruler, a misalignment exists between the x-ray port and the x-ray tube focal spot.

BEFORE MAKING THE FOLLOWING ADJUSTMENT, DOUBLE CHECK THE ACCURACY OF THE CENTER MARK MADE ON THE RULER.

g. If you are certain that the beam is actually off center, shut x-ray OFF. The position of the x-ray port is changed by moving the entire phototube chassis. Loosen the four corner mounting screws just enough to allow you to move the chassis by prying it with a large screw driver. Check to assure yourself that each screw is fitted with a lock-washer so that, when finally retightened, it has a reasonable chance of staying tight. Turn x-ray back ON and, using the fluorescent probe to check the position of the primary beam, pry the chassis so that the beam is vertical and horizontally centered to the center mark on the ruler. This accomplished, turn x-ray OFF and securely tighten all four mounting screws.

h. Turn x-ray back ON and recheck that the primary beam is centered to the center of the housing; then remove the ruler. Make a trial assembly of the lower half of the housing cover plate to the housing, using only 4 screws. Using the fluorescent probe, check that the primary beam, as displayed by the intensity and size of the fluorescent area, is passing cleanly through the port in the lower cover plate. If it is not, check that the x-ray port in the cover plate is in fact at the center of the housing, then remove the coverplate and recheck your previous work on alignment. When properly aligned, turn x-ray OFF.

i. If the unit will be used to inspect containers of one quart size or less containing fill material with a density equivalent to water, the shutter will not be necessary and should be taped to the coil so that it covers the x-ray port. In this way, the shutter will provide the filtration needed to permit using stable values of tube current without saturating the crystal. Make certain that the shutter completely blocks the x-ray beam. Examine closely the x-ray pattern on the fluorescent probe. The x-ray pattern should be of uniform intensity and there should not be a bright vertical line indicating incomplete coverage.

9.04 Test for Proper Shutter Operation

Proper operation of the unit when inspecting containers with thick walls (greater than about 0.20") of high density material (steel, tinplate, etc.) is dependent upon proper functioning of the shutter mechanism. If it is decided that the shutter will have to be used, the following checks must be made.

a. Be certain that x-ray is OFF. Remove the lower half cover-plate and inspect the shutter mechanism. Note that it comprises two coils mounted on a bracket which is attached to the base assembly by two screws. Due to the thin material used in the base chassis, these screws pass through the base chassis and are retained by lock-washers and nuts. The shutter itself is simply a bent over portion of the armature which is hinged to a point part way between the two magnet coils so that it can "teeter" in one direction or the other, depending on which coil is energized. This armature is so designed--and the materials so selected--that it can be actuated through one complete cycle per container for millions of cycles with a minimum of maintenance. Its nature and job is so exacting that it should be treated with the respect due such a mechanism.

b. Basically, its purpose is to prevent unfiltered or high intensity x-rays from reaching the crystal detector when there is no container in the beam. To do this, it must respond rapidly and move only far enough to protect the crystal from being energized by high intensity radiation and thus establishing an abnormally high level of signal output. Excessive motion of the armature results in delayed action.

c. Two adjustments are provided:

(1) To position the shutter so that it will just cover the x-ray port when "closed" and just clear the port when "open", the shutter assembly is moved by prying with a screwdriver after loosening slightly the two screws attaching the shutter assembly bracket to the base plate. If the screws are loosened too much it will be necessary to remove the entire assembly to retighten the nuts behind the chassis.

(2) To adjust the "throw" or motion of the armature, the armature can be bent by inserting a small screwdriver between the outer pole piece and the armature and carefully prying. The axle pin of the armature is designed to withstand those forces just required to bend the armature.

d. Now, recheck that the shutter is "open" and just clears the x-ray port. From a position directly in front of the port (x-ray should be OFF and a cover over the phototube), the right edge of the port should be just visible beyond the left edge of the shutter. In addition the vertical location of the shutter should be such that its upper edge is higher than the upper edge of the port and its lower edge is lower than the lower edge of the port.

If these conditions are not true, pry the shutter assembly into proper position after slightly loosening the mounting screws (as indicated under c(1).

e. Uncover the phototube so that the shutter is actuated to the closed position. From a position directly in front of the port (x-ray should still be OFF), the edge of the shutter should just cover the left edge of the port. If it is not, bend the armature by prying with a screwdriver until it is; then recheck the position of the shutter in the "open" position (phototube covered).

f. Re-perform b and c as necessary to obtain just sufficient "throw" to cause the shutter to just close off the port when closed and just clear the port when opened. Remember that excessive "throw" can introduce delays in the operation of the shutter which may cause difficulty in operation.

g. Now remove the cover from the phototube (if covered) and temporarily install both the upper and lower half cover plates using only a few screws for each half. Turn x-ray ON. Using the fluorescent probe, check that the shutter is open. If necessary, cover the phototube window temporarily with a piece of paper. Then remove the cover allowing light to strike the phototube, closing the shutter. If the ambient light is low, it may be necessary to shine a flashlight at the phototube window.

h. Examine closely the x-ray pattern on the fluorescent probe (shutter closed). The x-ray beam should be almost uniformly weak and there should not be a bright line indicating incomplete coverage by the shutter. Cover the phototube window. The shutter should open and the x-ray beam should be of uniformly bright intensity, displaying no evidence that the shutter is intercepting the right side of the beam. If either occurs, re-perform b, c, and d, changing the adjustment just enough to correct the difficulty and obtain proper alignment.

9.05 Phototube Positioning

a. Remove the lower half cover plate if previously installed and with a machinists square, check that the center of the phototube window in the coverplate is aligned vertically with the center of the x-ray port. If not, correct by scraping the black pigment from the window. Recheck and carefully lay the coverplate aside.

b. Check visually that the center of the phototube cathode (see Drawing 3591-D22, Phototube Chassis) is centered vertically with the x-ray port of the phototube chassis. If not, reposition

the phototube by shifting the phototube mounting bracket. Generally, sufficient movement can be obtained by slightly loosening the one bracket mounting screw just behind the lower vacuum tube (V303), and prying the bracket over with a screwdriver. Retighten the mounting screw. At no time should this screw be loosened more than is necessary to move the bracket by prying; otherwise you will lose control of the nut on the back side of the base chassis. Since this screw also acts as a chassis "ground", if control of the nut is lost it is imperative that the base chassis be removed and the nut tightened on the screw. Removing the base chassis will require re-aligning the x-ray ports again.

c. With the phototube cathode centered vertically with the x-ray port and the lock screw tightened, re-install temporarily the lower half coverplate to the housing. Inspect visually the alignment of the phototube window and the phototube cathode. If the phototube cathode is not aligned with the window estimate the amount and direction of shift required for the phototube. Remove the coverplate and shift the phototube mounting bracket by the amount required to align the window and the phototube. Recheck after retightening the phototube mounting bracket and re-attaching the lower half coverplate.

9.06 Detector Hood Assembly to the Head

After the preceding adjustments have been properly made within the terminal housing, recheck that x-ray is OFF and then temporarily attach the upper half of the housing, its gasket and the hood to the head, using 4 to 6 screws.

9.07 Light and Hood Alignment

The purpose of this section is to guide the installer in making this critical alignment. The basic concept of this unit requires that the center of the x-ray beam and the center of the light beam be vertically aligned along the entire length of the x-ray beam. There can be no compromise in obtaining this condition, and all appurtenances, both in the head and the conveyor must arranged to allow this.

a. X-ray still OFF, loosen the light housing attachment screws and using washers as shims on these screws, aim the light beam to the phototube window. The brightest portion of the light beam at the window, should be just large enough to completely cover the window without any dark or very bright spots on the window. Due to the dimensions of the filament of the light bulb, the light beam should be elliptical in shape with its long dimension horizontal. If it is not, or if the light beam is

larger or smaller than that required to just cover the transparent window, the light must be rotated within the housing or re-focused or both.

When this is required:

(1) Loosen the cable grip on the light cable at the back of the housing and slide the entire waterproof connection assembly back over the cable.

(2) With a long nose plier, grasp the metal bracket on the light socket within the housing and carefully push, pull, or twist the socket to obtain proper focusing. It may be necessary to further align the entire light housing so that the light beam is properly focused and aligned to the phototube window at the same time.

(3) When properly aligned, slide the waterproof connector back over the cable and secure to the housing. Make certain that the rubberized clamp effectively seals the cable.

b. Now, turn x-ray ON. Take a piece of paper and the fluorescent probe (or a piece of fluorescent screen material of about 3" x 5" size) and check the vertical alignment of the light beam and the x-ray beam at a position no more than 1/2" in front of the crystal housing. This can be readily done by standing below and at the end of the hood and moving the paper and screen up in front of the crystal housing so that both x-ray and light beams are intercepted and can be seen, the x-ray beam on the fluorescent screen, the light beam on the paper. The center of both beams must be in alignment, vertically, within ±1/16".

c. If they are not in alignment, adjust the light housing or teeter the hood by shimming at the phototube housing on the head. The basic concept here, is to get the light beam into alignment with the x-ray beam. Misalignment may be due to distortion in the hood assembly or due to shifting of the x-ray tube itself in its insulated lead shield. If, in order to obtain proper alignment, the hood must be shimmed at the phototube housing cover by more than 1/2", and the hood is not distorted, then the tube head should be exchanged or opened up for the purpose of checking and re-aligning the x-ray tube.

Regardless of the process used, the light beam and x-ray beam must be brought into alignment along their full length.

d. Once the focusing of the beam and alignment with the phototube and x-ray beam is obtained, recheck the phototube alignment as follows:

(1) Looking in through the window at the phototube cathode, check that the area illuminated by the light beam is centered with respect to the phototube cathode. If this is not true, remove the lower half cover plate and re-position the phototube mounting bracket until it is.

(2) With the coverplate in position on the phototube housing, check that the output voltage of the phototube cathode follower is adequate for proper operation of the unit.

(3) a) Connect a d-c voltmeter of at least 20,000 ohms per volt sensitivity (50 volt scale) between TB400-17 and chassis ground (or TB400-4). With no object in the light beam, the voltage should be at least -20 volts. Record the actual voltage.

b) Position two containers 1/8" apart in the light beam so that the light through the 1/8" space shines on the center of the phototube window. (An alternate method would be to cut a 1/8" slot in a piece of paper and position the slot accordingly). The voltmeter should read at least -9 volts. Record this actual voltage also.

c) If the voltages in the above two tests do not meet the minimums specified, trouble exists in the unit. Clean the phototube window and light lens. Replace phototube and light. Replace V302, check voltages at both the phototube chassis and the control. Trace the phototube head circuits and the head to control leads in this circuit.

d) After cleaning trouble with these tests, block the light beam from the phototube by covering the phototube window with a piece of black tape. The voltmeter across TB400-17 to ground should read some positive voltage. The value is relatively unimportant as long as it is positive. If it is not, suspect the phototube or V302 or their associated circuits. Record the final value.

e) Now remove the black tape from across the phototube window, but block the light at some point near the light housing. The voltmeter reading should still be positive.

The possibility of this voltage now being negative is generally indicative of high surrounding light level which may interfere with proper operation of the unit. The installer should note this basic test for this condition. Final testing should be done later, after the installation is completed and the unit is in its final position ready to inspect containers.

9.08 Crystal Positioning

a. Crystal positioning is merely the process of mechanically aligning the crystal housing to the center of the x-ray beam so that optimum signal is obtained from the crystal (or crystals) contained therein. As connected in the circuit, a crystal produces both an a-c and a d-c signal in response to x-radiation striking it. In the usable range, both signals increase with increased radiation energy, however, changes in d-c output are relatively slow as compared to the a-c changes with respect to changes in intensity. For this reason, only the a-c signal is utilized by the Hytafill for inspection purposes, however, the d-c voltage may on occasion be used because of the higher reading to determine the condition of the crystal. The a-c voltages found in these tests will usually be below 1.0 volts while the d-c voltages may be as high as 40 or 50 volts.

b. Basically, both the a-c and d-c signals are fed from the crystal directly into the V301 cathode follower stage, the cathode resistance of which is the GAIN pot located in the amplifier chassis. Both d-c and a-c signals are therefore present at the terminal boards involved in the interconnection between the head and the control and the amplifier chassis. Two points, however, are more accessible than the others; TB400-20 on the amplifier chassis in the control, and Test Points 5 (single crystal) or 5 and 6 (double crystal) accessible through the access panel on the left hand side of the phototube housing. At either of these points the installer can utilize whichever type of voltage indicating meters he desires as long as the equipment used has a resistance of at least 10,000 ohms per volt to d-c and 1,000 ohms per volt to a-c. Since the serviceman's testmeter will probably be the most readily available instrument, these instructions will be based on its use. An oscilloscope, vacuum tube voltmeter, decibel meter, or any other type voltage instrument meeting the above minimum specs can be utilized as long as reasonable care is used to prevent confusion or misinterpretations. The following factors may be of interest to the installer to aid in understanding readings taken at these terminals.

(1) A reading of approximately 6 to 7 volts d-c, which does not increase as ma and kvp are increased, is cause for suspecting an "open" crystal.

To check the crystal, shut off all power to the Hytafill, remove the crystal. In subdued light, check its resistance with the high resistance scale (at least x1000) of the serviceman's test meter. A resistance value should be indicated and this value should vary with the amount of light involved. It should not be too difficult to obtain a reading as low as 2 megohms with a reasonable amount of light. Do not apply so much light that the resistance will drop below 10K.

Although this is not a test of quality of the crystal, it does provide sufficient indication to justify looking elsewhere if the crystal performs as stated.

(2) There is no definite significance to be attached to the fact that one crystal produces a circuit reading of 12 volts d-c and another a reading of 50 volts d-c in the Hytafill. However, in general, a "hot" crystal producing the higher voltages may have a tendency to become quite noisy or sluggish (see next section) while a low output crystal may require higher x-ray tube currents for satisfactory operation. In general, a reading in excess of 50 volts d-c at 110 primary volts and 1.0 ma is indicative of a crystal too sensitive for general utilization or one whose resistance is too low to be of practical value and should be replaced. The actual a-c reading is insignificant so long as it is high enough for operation. The minimum value is approximately 0.15 volts as measured on the 3 volt scale of a 1000 ohm per volt meter with the meter selector set at OUTPUT.

(3) Whatever the reading obtained, this reading should be steady with no change in beam filtration (i.e., no objects being moved into or out of the x-ray beam). It may be helpful for this check to set the test meter for 50 volt d-c so that any fluctuations will be more readily observed. Erratic or unstable readings are indicative of a noisy crystal, poor connections in this circuit, or erratic x-ray beam due to poor line, gassy tube, etc. If this condition occurs, it is suggested that a new crystal be tried, if immediately available. Turn power to the Hytafill OFF before attempting to uncover or remove the crystal. Failure to do so may destroy the crystal.

Whatever the reason for such erratic fluctuations, correct the situation before proceeding further as abnormal rejections may cause considerable difficulty in making final adjustments.

c. If the unit being installed is a dual channel unit, it is strongly recommended that the unit be initially installed, adjusted, and operated for a period of time as a single channel gage, using the lower crystal of the dual crystal assembly and the lower amplifier. After operation on the customer's production line has been observed and the affects clearly understood, the upper channel may be activated, adjusted, and the crystal spacing set. This recommendation is made because the spacing between crystals is somewhat dependent on the affects of the customer's conveyor on the unit. Observation of operation on Underfill only will greatly assist in experimentally setting the spacing to obtain the optimum degree of accuracy of Overfill indication.

d. Proceed with alignment as follows: (description based on the use of a test meter with a resistance of at least 1000 ohms per volt on a-c)

(1) Connect a-c voltmeter between TB400-20 (or appropriate test point at head) and ground. (On "Underfill" or lower amplifier if this is a dual channel unit using a dual crystal assembly. Use the OUTPUT range selector and approximately 3 volt range.

(2) Back off the screws (Allen head) that lock the crystal housing positioning knobs just far enough to allow rotation, yet still maintaining sufficient pressure to hold the crystal housing in any desired position. The upper control is intended to provide basically vertical movement and the lower control horizontal movement. However, since the motion produced by each adjustment knob is rather complex, experiment with the adjustments and observe the motions produced so as to get the "feel" of the adjustments.

(3) Block the light to the phototube to open the shutter 2 ma and 110 primary volts.

(4) With the fluorescent probe check that the shutter completely covers the x-ray port.. Regardless of whether the shutter will or will not be used, it should be closed for this adjustment.

(5) Using the fluorescent probe, locate the x-ray beam at or near the front of the crystal housing.

(6) Using the adjustment knobs to attain the following conditions:

a) Horizontal direction - for maximum voltmeter reading.

b) Vertical direction - for alignment of the crystal to the center of the x-ray beam. (Beam is broad vertically.)

(7) Depending on the characteristics of the crystal used, it may be possible to observe a peak reading on the voltmeter as the crystal housing is moved. Should this occur, the crystal must be aligned for maximum a-c voltage output. In some cases, this may mean the final crystal position will be slightly off center, however, the displacement will be very slight and usually not evident visually.

(8) If a dual channel unit is being used, utilizing the dual crystal assembly, note the voltage obtained in the previous step and then reconnect the voltmeter to TB400-20 on the "Overfill" or upper amplifier chassis. Then repeat the alignment procedure to obtain maximum or peak a-c voltage output from the upper crystal.

(9) After the adjustment has been completed for the upper crystal, check that the lower crystal is still set for maximum output. If it is not, repeat the procedure until both crystals are properly aligned.

On dual channel units, the spacing between the upper and lower crystals can be adjusted by mechanically bending the crystal support wires. Due to affects caused by most conveyors, the exact spacing must generally be set experimentally and rechecked by observing the operation of the unit during production. It must be remembered that changing the crystal spacing may affect the amount of radiation reaching it and the crystal output must, therefore, be checked each time a change is made to make sure operation is on the usable part of the output curve.

(10) If any question or doubt exists as to the proper position, align the lower crystal for maximum as if the unit were a single channel unit, centering the crystal horizontally for

maximum and vertically for center of beam (the beam is rather broad vertically). Then proceed to check out the complete unit, using the Underfill crystal (and lower amplifier) only. After several weeks of operation and after both the customer and yourself are satisfied with the overall operation of the unit itself, the Overfill channel can be activated and any compromises required may be made and their effects observed.

(11) Lock the adjustment knobs carefully so that the adjustments will not be upset. Close observation of the meter readings will indicate whether this is occurring.

(12) As a final check on each crystal, decrease primary volts from 110 to zero while watching the test meter. If alignment is correct, the output voltage will decrease. If it is not correct, the output voltage will increase during a corresponding decrease of primary volts.

(13) If alignment is correct, disconnect the test meter leads before continuing with the following adjustments as the meter load may have an affect on subsequent control settings.

(14) Now, complete the attachment of the hood to the tube head, installing and tightening the remaining screws, carefully observing the above meter readings and the position of the light beam on the phototube window as indications that the above alignment is being upset. Naturally, a change in alignment should be avoided. If it appears to be occurring during the process, compensate by tightening screws in other positions about the hood cover plate. If the hood has been shimmed to obtain proper light beam, x-ray beam alignment, each added hood attachment screw must be fitted with proper shims for the position of the screw involved--to prevent upsetting previous adjustments.

10.00 OPERATIONAL TESTS AND ADJUSTMENTS

10.01 The tests and adjustments covered in this section presume that the application of the unit is such that the shutter may be left inoperative. That is, used for inspection of standard size containers of beer, soap, milk, fruit juices, etc. For special applications, refer to the tests and adjustments in the special directions accompanying the equipment.

10.02 Before beginning this section, either for initial or subsequent adjustment, the installer must be certain that all the requirements outlined in the preceding section "Preliminary Tests and Adjustments" have been met.

10.03 As stated previously it is strongly recommended that the overfill channel, in the case of a dual channel unit, be left inactive until operation of the underfill channel, in conjunction with the customer's conveyor, is proven satisfactory and thoroughly understood.

10.04 To facilitate these adjustments, it is recommended that a pilot lamp (Type C-7 or equivalent) be installed in a visible location and connected across the electrical leads to the reject air valve, if used, or to 115 volts through the appropriate Reject Relay contacts to indicate reject action when called for by the Hytafill (either chassis).

10.05 Reject Potentiometer Adjustment

Since the operation of this circuit is not dependent on the crystal signal or the setting of any other control, the Reject Potentiometer may be adjusted or its setting checked without disturbing any of the other controls.

a. Turn the line switch ON, leave x-ray OFF.

b. Set Under-Overfill switch on Overfill.

c. Set the Reject Control fully counterclockwise (CCW).

d. Hold S702, toggle switch marked PHOTOTUBE, in the test position.

e. While slowly pressing and releasing push-button S703, turn the Reject Control Clockwise (CW) just until consistent reject action occurs when S703 is released.

If the Reject Control is turned further, reject action will still appear consistent but reject action will not occur at the proper time.

f. Lock the control at this setting and check that operation is still proper.

g. Repeat for other chassis, if required.

10.06 At this point in the initial adjustment, a final check of phototube alignment should be made. After installation this check need not be made unless the phototube has been replaced or the circuit is suspected of being out of alignment.

a. With x-ray OFF and the amplifier set for Overfill, pass a rule or other object with straight edges, held with the long dimension vertical, across the phototube window and x-ray port. Listening for the reject relay, or air valve, to actuate and at the same time passing the object across the phototube window as described, mark a line alongside the x-ray port, along the trailing edge of the rule, at the position at which the reject relay operates. If the air valve is not connected, it may be helpful to connect the test meter across the reject relay contacts to indicate operation. Repeat the above procedure but move in the opposite direction. Ideally, the x-ray port should be about half-way between the two marks. Actually, proper operation can be obtained if neither mark is closer to the x-ray port than 1/8". If one mark (or both) is closer than 1/8", recheck the positioning of the marks, passing the object across the face of the housing, keeping the straight edges as near vertical as possible. If one mark is still closer to the x-ray port than 1/8", the phototube must be shifted, a new phototube tried, or a new light tried, in the order named.

b. In any case, do not proceed beyond this point until the 1/8" minimum distance is achieved as to do so would be a waste of time. Further sources of difficulty may be poor V302 tube, or a fault in the stage or its plate or heater supply voltages. As a last resort, the phototube window may be lengthened by scraping off the black masking material. This, however, should not be done until you are certain that none of the other circuits or components are faulty. If in doubt, recheck Sections 9.05 and 9.07.

10.07 Gain Control Adjustment

For containers involving fluids with a density approximating that of water (beer, milk, soda pop, fruit juices and concentrates, etc.):

a. Turn line switch ON.

b. Turn x-ray ON.

c. Set Under-Overfill switch to UNDERFILL.

d. Set the Gain Control fully counterclockwise (CCW).

e. Set Primary Volts at 110 and adjust Filament Control for 2 ma. Unless changed, this is the Operating MA.

f. Insert a full container in the inspection position.

If the tube head is tilted upwards a convenient method of holding the container in place is to fasten a piece of sheet metal, bent to form an angle, to the cover over the cathode follower chassis with a "C" clamp.

g. Check that x-ray is penetrating liquid for the full diameter of the container but not through a seam.

h. Hold S702, toggle switch marked PHOTOTUBE, in the test position and as rapidly as possible, repeatedly press and release S703 to simulate containers passing through the inspection position.

i. Increase the Gain Control (CW) while actuating S703 until consistent reject action just occurs.

If no reject action is obtained at maximum gain setting, reconnect the test meter (set on output and lowest a-c scale) to TB400-20 of the chassis being adjusted and ground. If a test meter reading, with a filled container in the inspection position, of more than 0.15 volts is obtained reject should occur. If it does not, it will be necessary to trouble-shoot the amplifier.

If the test meter reading is less than 0.15 volts, check the d-c voltage at this same point. A reading of at least 6 volts should be obtained if V301 is functioning properly. If the crystal is not defective, the reading should increase as the container is removed from the inspection position.

If the above checks indicate the trouble is not in the circuitry, but strictly low output, increase ma in 0.5 ma steps, realigning the crystal after each increase, until reject action is obtained. Any value up to 5.0 ma is permissible, but water cooling must be provided in accordance with Section 3.03.

j. Lock the control at this setting and check that operation is still proper.

k. Repeat for other chassis, if required.

10.08 Setting Operating Primary Volts

If a dual channel gage is being installed complete steps "a" through "i" for the chassis to be used for Underfill inspection before repeating for the chassis to be used for Overfill inspection.

a. Leave the full container in the inspection position.

b. Set Under-Overfill switch to UNDERFILL.

c. Set Primary volts at 100 volts.

If a dual channel unit is being adjusted temporarily demobilize the amplifier not being adjusted by removing V401, first amplifier tube.

d. While holding S702 in the test position and actuating S703, increase Primary Volts until reject action occurs but is not yet consistent.

e. Note the primary voltage value and call it X_2.

f. Place an empty container in the inspection position.

g. While holding S702 in the test position and actuating S703, decrease Primary Volts until reject action becomes inconsistent.

h. Note the primary voltage value and call it X_1.

i. Calculate the values of X:

$$X = \frac{X_1 + X_2}{2} + 3$$

Repeat steps "a" through "i" for other chassis, if required.

j. Set the Operating Primary Volts for the value of X calculated for the chassis used for underfill inspection. The values of X for the two chassis should be within 5 volts of each other.

k. Check that there is a difference of at least 5 volts between the Operating Primary Voltage X and X_1 (both chassis, if used) and 5 volts between the Operating Primary Voltage X and X_2 (both chassis, if used).

If the difference is less than 5 volts, recheck. Generally, $X_2 - X_1$ will be between 18 and 25 volts.

l. Record the values of Operating Primary Volts and MA on the labels on the respective meters.

Included with this direction is a sheet of adhesive-backed paper for use in recording the voltage and ma values. Since the labels will not adhere to the metal cut out small squares and stick them in a corner on the meter glass.

10.09 Operation Check

a. Lower the tube head over the conveyor (if previously raised).

b. Set the level of the head so that the x-ray beam is at least 1" below the level of fill at which the customer desires to inspect.

c. Using a spirit level and the fluorescent probe, adjust the leveling of the head so that the center of the x-ray beam is roughly horizontal as it traverses from head to crystal.

d. Adjust the leveling nuts so that a line extended vertically between the center of the x-ray port and the center of the phototube window, at the phototube cover plate, is truly vertical as viewed from a position facing the cover plate. Recheck also that a line drawn vertically between the center of the x-ray beam and the center of the light beam--at a position 1/2" in front of the face of the crystal housing--is also truly vertical. The accuracy required of these vertical adjustments will depend somewhat on the speed with which containers are expected to be passed through the inspection position. At speeds between 300 - 500 cans per minute, proper adjustment can probably be made "by eye", without the use of a spirit level. At speeds in excess of 500 cans per minute, a spirit level should be used. After completing the vertical adjustment, recheck that the horizontal adjustment described in "c" is still roughly correct. Be careful at all times to keep all parts of the body out of the x-ray beam, working from the side and utilizing only sufficient x-ray Primary Voltage and Ma to make the beam visible on the fluorescent screen.

e. If the unit is a dual channel unit, demobilize the amplifier to be used for overfill inspection by removing its main fuse. Check that the under-overfill switch is on "under" on the amplifier to be used for underfills.

f. With unit "ON" and x-ray "OFF", apply compressed air and electrical power to the customer's reject valve.

g. Passing containers through the inspection position (extent of fill of containers not important for this test) or if possible allow production containers to be passed through the position in normal manner at normal conveyor speeds, throw the under-overfill

switch of the underfill chassis to overfill allowing the rejection of 10 - 15 containers. Adjust the TIME control and adjust the position of the air reject nozzle so that every container is cleanly rejected. Compensate for any troubles in the handling of rejected containers so that all containers are cleanly handled and cause no blockage of the production line or the ability of the unit to reject many containers as fast as they pass through the Hytafill. If any problems occur at this stage, it is important that they be relieved or resolved before proceeding, as the effects of improper rejection can confuse both the installer and the customer during later tests. It is suggested that if a question arises, that the installer review Sections 3 and 4. In particular, if the customer expects to later apply his own tests on the operation or accuracy of this unit, it is extremely important that all matters pertaining to container handling and rejection be clarified at this time, and it is for this reason that it is particularly desirable that production be in operation during the above tests. If such cannot be done at this time, then the tests should be repeated as soon as such can be done. Further, it should be particularly noted whether or not stoppages in the conveyor line which may occur due to equipment positioned along the line following the Hytafill do not result in the build-up or jamming of containers at the Hytafill position. If such condition cannot be corrected, the matter should be discussed with the customer and the possibility of rejection of containers not properly inspected explained to him.

h. After the installer is assured of proper adjustment of the reject circuits under the above tests, it is suggested that the unit be operated at the low inspection level specified with x-ray ON and the under-overfill switch set on underfill for at least a full 8 hour shift of production. During this period there should be no rejection of containers filled to a level in excess of 1/2" above the level of the Hytafill as set. Empty containers, singly and in groups of 5 to 10, should be passed through the unit periodically to assure its ability to reject such containers. Occasionally the Primary Voltage should be increased at least 10 volts above the operating setting (but not in excess of 110 Primary Volts) for a few moments as a check as to whether or not the unit is becoming more sensitive with time. During the initial warm-up (30 to 60 minutes), the primary voltage span will drift until the amplifier circuits have warmed up. Tests should be avoided during this period as their results may be confusing. The presence of rejections of properly filled containers during the above tests should be considered as trouble in the unit, and should be cleared using the trouble-shooting charts if necessary. Until the unit is made to operate in the manner described above, it is suggested that no attempt be made to raise the level of the unit to the de-

sired inspection level, as to do so would confuse both the installer and the customer at this time.

10.10 Final Adjustment of Inspection Level

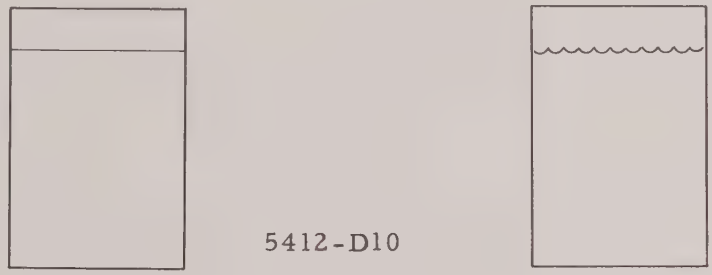
a. Final adjustment of inspection level can be an exceedingly simple process or an exceedingly confused one, depending on the conditions of operation required of the Hytafill. To assist the installer in establishing the inspection level, it is suggested that the following factors be thoroughly studied and understood. It is assumed throughout the discussion that the cans being inspected are passed through the Hytafill in orderly fashion, at least 1/8" apart, with no jamming etc. as prescribed under Section 3, Installation Requirements.

1. The accuracy of the Hytafill is stipulated as ± 1/64" (approximately 2.5 grams of beer in 12 oz. cans). Basically this means that the level of fill at which the Hytafill will reject is subject to change with time over a range nor exceeding ± 1/64". This is a rather theoretical figure of accuracy based on its use on a perfectly smooth conveyor, the fluid level being checked being ripple-free with no foam (or consistent foam with no variation between cans). From a practical point of view, the accuracy figure of ± 1/64th per inch means that, with a given level of the Hytafill (let us call this the "inspection level"), it will assuredly reject as underfill all containers in which the liquid level is below the "inspection level" by more than 1/64" and may reject any whose liquid level is within the range of ± 1/64" of the "inspection level". It must be emphasized that this accuracy is based on the conditions that no ripple is present in the containers. It is also effective if the extent of rippling is minor and is always the same in all containers or if the extent of foaming is always the same in all containers (and the level of the Hytafill set to compensate for these conditions). Since neither of these conditions can be accurately measured by any direct and simple means, we can only reach the conclusion that there are deviations from these conditions only indirectly--after "ruling out" or eliminating other factors which can cause the same effects.

2. It can be presumed that a Hytafill which operates correctly under 10.07 will, in fact, reject all containers through which the crystal receives at least one x-ray pulse of rejection intensity. Therefore, once a Hytafill passes that test, (and until something within it fails so as to prevent it from continuing to pass that test), it should be assumed that the

that the Hytafill rejected the container because the crystal actually "saw" a rejection pulse. The question then becomes one of determining why the crystal "saw" the rejection pulse. Note particularly that only one pulse is needed to cause rejection and that the entire liquid level within a particular can or container need not be low in order to allow passage of only one pulse.

3. Note Illustration--Both cans contain the same amount of liquid.



Illustration

A Hytafill, set to just pass the level of fill of Can A will most assuredly reject Can B. In order that this same Hytafill be set to pass Can B, its level must be lowered by an amount equal to 1/2 the distance between peaks and troughs of the ripple. From this we can get a "rough" estimation of the extent of ripple by first setting the level of a Hytafill to just pass a filled can set stationary in the inspection position; then resetting the Hytafill lower by an amount that will just still pass the same can moved through the inspection position on the conveyor. Care in such a test must be taken to prevent changing the extent of foaming within the can.

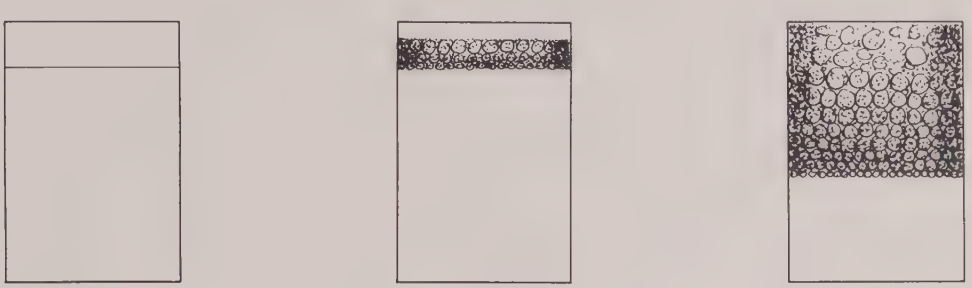
4. Experience indicates that all conveyors produce some ripple, requiring that the level of the Hytafill be established from containers in motion at actual conveyor speeds. Experience also indicates that the extent of rippling may vary with individual conveyors, from time to time, depending on the condition of loading, maintenance, etc. of the conveyor. (Experience as to the best type of conveyor is quite confusing since each type requires its own particular type of maintenance and reacts differently at different speeds and under different loads.) Further, experience indicates that occasionally, within a particular can or container, the ripple present may

build up, as on a lake or ocean, to form "waves" of considerable size. The extent of such "waves" may vary, of course, and have been observed to extend to as deep as 5/8" below the true level in a 12 oz. beer can. Whether or not containers in which "waves" have developed will be rejected will depend on the depth of the "wave", the true level or stationary level of the fluid, and the level of the Hytafill. It is because of these effects that the Tests of Section 10,07 are performed at a Hytafill level of at least 1" below normal level. Further, it is because of this that most Hytafills, as finally set at their normal inspection level, may be observed to reject some containers whose level of fill may be considerably in excess of the level for which the Hytafill is set. It is also because of this that a Hytafill, set to reject Overfills, may fail to reject some Overfills, even if overfilled by a considerable amount. It is important to note that the generation of "waves" is haphazard and not consistent. Because of this, the same can, if rejected because of "waves" developing within it, when repassed through the Hytafill, will generally not be rejected.

5. Re-emphasizing the effects of a rough conveyor in producing a relatively consistent ripple in all cans plus an occasional "wave" haphazardly in some cans, the number of properly filled cans rejected in any period will depend on the depth of the "waves" produced plus the relation of the average fill of the cans to the height of the Hytafill. The effects are somewhat statistical and evade conclusive evaluation. Quite obviously, for a conveyor which happens to be producing "waves" in cans, if the Hytafill is set to reject all fills under 420 grams and the filling equipment is filling cans to an average of 425 grams, there will be more rejects due to "waves" than if the Hytafill were set to reject all under 410 grams. For this reason, a customer attempting to fill containers at an average fill close to the set level of the Hytafill may, if his conveyor causes "waves", experience objectionable numbers of rejections of properly filled cans in addition to any low-filled cans present. If such were to be reduced, the customer must either (1) improve the conveyor, (2) increase the average fill, (3) reduce the inspection level of the Hytafill, or (4) perform all three together or in pairs. Generally, it is impractical to eliminate all rejections of properly filled containers. The number of rejections of properly filled containers accepted as reasonable by breweries varies with the brewery. In some breweries, one such rejection per minute is accepted and others require that no more be rejected than one per hour. In general, it is desirable that some such re-

jections occur, if for no other reason than to assure that the Hytafill is, in fact, operating and would not pass empties.

6. Note Illustration--Both cans A and B contain the same amount of fill by weight; can C contains less by weight but is



A B C

Illustration

heavy with foam. Obviously, a Hytafill set to just pass Can A will probably not reject either Cans B or C unless the x-ray beam is sufficiently intense as to penetrate the foam. It is important that the Operating Primary Voltage be set in accordance with the instructions of 10.06 to prevent the passage of a can filled such as in Can C. Therefore, the Hytafill set and maintained to just pass Can A, will reject Can B and Can C. If the cans normally being processed in production are normally foamed to the extent of Can B, it is obvious that the Hytafill must be set lower to properly pass them. For this reason, "test cans" with their questionable degree of foaming should not be used for accurately setting the level of a Hytafill. Further, the locating of a Hytafill on a portion of the production line where the extent of foaming is liable to vary will probably prove unsatisfactory to a customer unless he is willing to set the Hytafill at a level sufficiently low as to eliminate the high rejection rate of properly filled cans that may occur.

7. Due to characteristics of those Hytafill elements which are responsible for the ± 1/64" stated accuracy, the rejection level of the Hytafill is somewhat dependent on the Operating Voltage set in the Hytafill control. Conveyor roughness also has an effect on this and it is possible to reduce the rejections of properly filled containers caused by the conveyor by reducing the Operating Voltage. Since a reduction in Operating Voltage below the proper value set in accordance with the instruction provided in 10.06 may result in insufficient x-ray generation to penetrate through foam in the can, this recourse to reduce unwanted rejections should never be used, else a

low filled can may be passed.

8. If it is desired the Hytafill be made to inspect at extreme accuracies, some consideration must be made to normal variations that can and do occur in the cans themselves. For a given level of fill, a can with a bulged bottom or of slightly oversize diameter will hold more liquid than a normal can. Another way of saying the same thing--for a given amount of fill material, the level of the surface of the fill will be lower if the bottom of the container is bulged or the diameter of the can oversized. One brewery has determined that, for a given fill level, the amount of fill material to meet the level can (but usually does not) vary as much as 7 grams due to variations in the container, assuming these variations as to be within the tolerances of acceptance by bulge can detectors, etc. Since such variations are generally not the rule and since many breweries would just as soon see such abnormal containers rejected in any case, the effect of these container inaccuracies is merely to make any attempts to monitor the Hytafill by laboratory methods of volume or weight measurement rather complicated, confusing, and somewhat inaccurate. Since other elements of laboratory measurement (such as variations in can weight and the amount of liquid retained by the can or beakers when the container is emptied) are somewhat variable, it is generally desirable to select--and stick with--only one method of measurement for use in setting the Hytafill. The method found most practical is to measure the weight of the rejected cans with a laboratory-type balance scale placed near the Hytafill. Utilization of production type "go - no go" balance scales or spring scales can generally be used if the goal of the customer is to merely reject low filled containers without too much concern as to exactly what level is rejected and what is not. For greater accuracy however, the laboratory scale must be used and the results interpreted carefully. In general, highly accurate, encased laboratory scales are too accurate to be useful and can cause confusion--due to the factors previously just mentioned.

b. Many methods can be used to make the final adjustment of inspection level, depending on the accuracy desires of the customer. Probably the most universally applicable method is as follows:

1. With production cans passing through the Hytafill and the Hytafill checked out at a low level as described in 10.07, raise the Hytafill evenly, the same amount on all four adjusting screws in increments of two full turns of each adjusting

nut, keeping the Hytafill level, until the Hytafill starts to reject some containers.

2. Immediately inspect each rejected container visually for dents or bulges and if found free of these, place it back on the conveyor at least 6 feet ahead of the Hytafill. If it now passes, it can normally be assured--unless other data indicates to the contrary--that the container is adequately filled and that rejection had occurred due to the development of "waves" within the fill or possibly an abnormal condition of foaming. If the container is rejected the second time, weigh it, mark its weight with indelible pencil and set it aside. Go through this process for each can rejected by the Hytafill, setting aside rejected cans of equal weight together into separate piles or groups. Gradually, as more cans are rejected a pattern of rejections will become obvious by virtue of the number of cans in the groups of rejected cans. However, do not become confused by the large number in several of the piles as this may only mean that, in the production process, there are statistically more cans being filled to this weight than of the others.

3. Select from the heaviest group of rejected cans, an undented can which has set for at least 5 minutes. Make certain it is marked so it can be retrieved if unrejected, and reinsert it on the conveyor 6 feet ahead of the Hytafill. If it is unrejected after at least two such "passes", select undented cans from the next lighter group and repeat until the weight which is consistently rejected is established. Now, since this test involves "stabilized" cans involving probably less foam than those on the production process, we have established--within the accuracy of weight measurement, can consistency, etc. previously discussed--a level below which the Hytafill appears to reject all containers. If desired, recheck this by passing through more undented containers from the weight groups that are lighter than the level established above, being careful not to cause more foaming.

   Now, knowing the level at which the Hytafill is now set, and recognizing that changing the level nuts on the base of the head by one turn will change the head level by 1/13th of an inch, reset the head to approximately the level which the customer thinks he wants. Note the number of rejections of properly filled cans. If this number is large requiring additional personnel to recheck these cans, the customer may find it more convenient to change his desires as to the level of inspection required of the Hytafill or perform work on his

conveyor, or both. It must be remembered that the Hytafill, as set to a level based on no foam, will reject containers of equal weight but foamed to some extent during the production process. If the amount of foaming appears consistent, the customer might find it logical to lower the established minimum level by the amount of foam, recognizing that the Hytafill will reject all containers with this amount or greater foam. The amount of foam can generally be assured to be represented by the difference between the heaviest weight consistently rejected in (2) and the unfoamed level determined in (3).

In this process of searching for the Hytafill level which will provide maximum usefulness to the customer, it must again be remembered that, for one particular set level of the Hytafill, the level of fill at which rejection occurs may vary over a range of ± 1/64" (or approximately 2.5 grams in 12 oz. beer cans). Within these limits, a properly operating Hytafill will reject what it "sees" as low filled. If conveyor roughness or foaming occurs, the containers may be made to look (to the Hytafill) as low fills and thereby be rejected. Because of these rejections, if they occur in large numbers, it may be desirous that the Hytafill level be reduced. At this new setting, the Hytafill will still be accurate to within the limits of ± 1/64" of this new setting as indicated previously. Recognizing further, however, the inherent inaccuracies in attempting to measure true fill by weight or other laboratory methods, it should become apparent that attempts to obtain high accuracy may, on most conveyors, be very, very difficult; and in general, really need not be obtained. Since the same factors of measurement and interpretation of results apply equally to weighing machines--plus a few other anomolies typical of these machines--attempts to make direct comparisons purely on the basis of accuracy may be quite inconclusive and even misleading and for these reasons alone, are discouraged.

c. Following the establishment of final inspection level as described, it is suggested that the installer go over the operating procedure given in 11.00 with those of the customer's employees who may be called upon to start up the unit, allowing them to actually go through the procedure with the installer as witness. In addition, the periodic inspection servicing and the adjustment procedures should be gone over with customer's maintenance employees; again, allowing them to carry out the steps in the installer's presence so that action can be taken in the installer's absence.

The installer should be on hand and observe at least one full day's operation as an aid to getting the customer started correctly.

For several weeks thereafter, the customer should be visited at least once a week to observe operation and to answer any questions which may develop. As the customer becomes more acquainted with the unit, its operation and maintenance, the length of time between visits may be increased.

11.00 OPERATIONAL PROCEDURE

11:01 The steps outlined herein presume that the unit has been properly adjusted and is ready for use on a production line.

11:02 Approximately one-half hour before inspection is to begin energize the unit with either the Line ON-OFF Switch on the control panel or an external switch, if used.

11:03 Observe that the red light lights immediately and after the one minute time delay the green light lights and the a-c voltmeter and milliameter read properly.

11:04 If desired, reset the reject counter on the amplifier panel.

11:05 Perform the checks listed for the 8 hour maintenance schedule in Appendix II.

11:06 Shortly before the production run begins, pass several known empty and several known overfilled containers through the inspection position to determine that the entire unit is functioning properly.

11:07 During the production run occasionally pass an empty container through the inspection position to check the operation of the unit.

11:08 At the end of a production run leave the unit energized unless another run is not scheduled for several hours.

12:00 INSTRUCTIONS FOR REPLACING THE X-RAY TUBE

12:01 Materials required:

Quantity	Dwg. or Cat. No.	Description
1	D0032C	SPI-100 Coolidge tube
10 gal	GE Type 917	Insulating oil
3	12-645	Oil filler plug gasket
1	29-306	Oil filler tube
1	N	Thermometer, range 32°F to 212°F
1	N	Pinch clamp for oil hose
1	N	Empty container, approximate capacity 10 gal.
1	N	Wood Dowel, 1/4" x 12"

12:02 Removal of tube:

a. Disconnect unit from power source.

b. Disconnect water cooling lines at tube head, if used.

c. Remove the x-ray protective hood containing the light source and crystal detector.

d. Remove the cover from the tube head terminal housing.

e. Disconnect all leads from the tube head terminals and photo-tube chassis terminals.

f. Be sure all leads are identified so that they can be reconnected correctly.

g. Remove the oil expansion tank cover and the lead bellows compression disk.

h. Remove the four rods securing the tube head to the base brackets.

DO NOT DISTURB THE ADJUSTMENT OF THE BASE BRACKETS.

i. Tip the tube head onto its back exercising care to insure that the paint is not marred.

j. Fasten a pinch clamp to the expansion tank hose about one inch from the head fitting and remove the hose from the head fitting.

k. Remove the oil filler plug at the top left corner of the tube head cover plate.

l. Remove the bolts securing the tube head cover plate to the tank.

m. Lift out tank cover along with integrally mounted transformers and x-ray tube.

n. Remove the screw securing the high voltage lead to the x-ray tube anode.

o. Disconnect the cathode high voltage lead and the filament leads.

p. Remove the screws from the two metal clamps securing the x-ray tube to the tank cover plate.

q. Carefully lift the x-ray tube away from the cover plate so as not to damage the oil displacement cone positioning the x-ray tube.

r. CAUTION: In the event tube replacement cannot be completed in a scheduled working period, the transformers on the cover plate must be reimmersed in oil to minimize the absorption of air.

12:03 Cleaning:

a. Discard the old oil in the tube head tank.

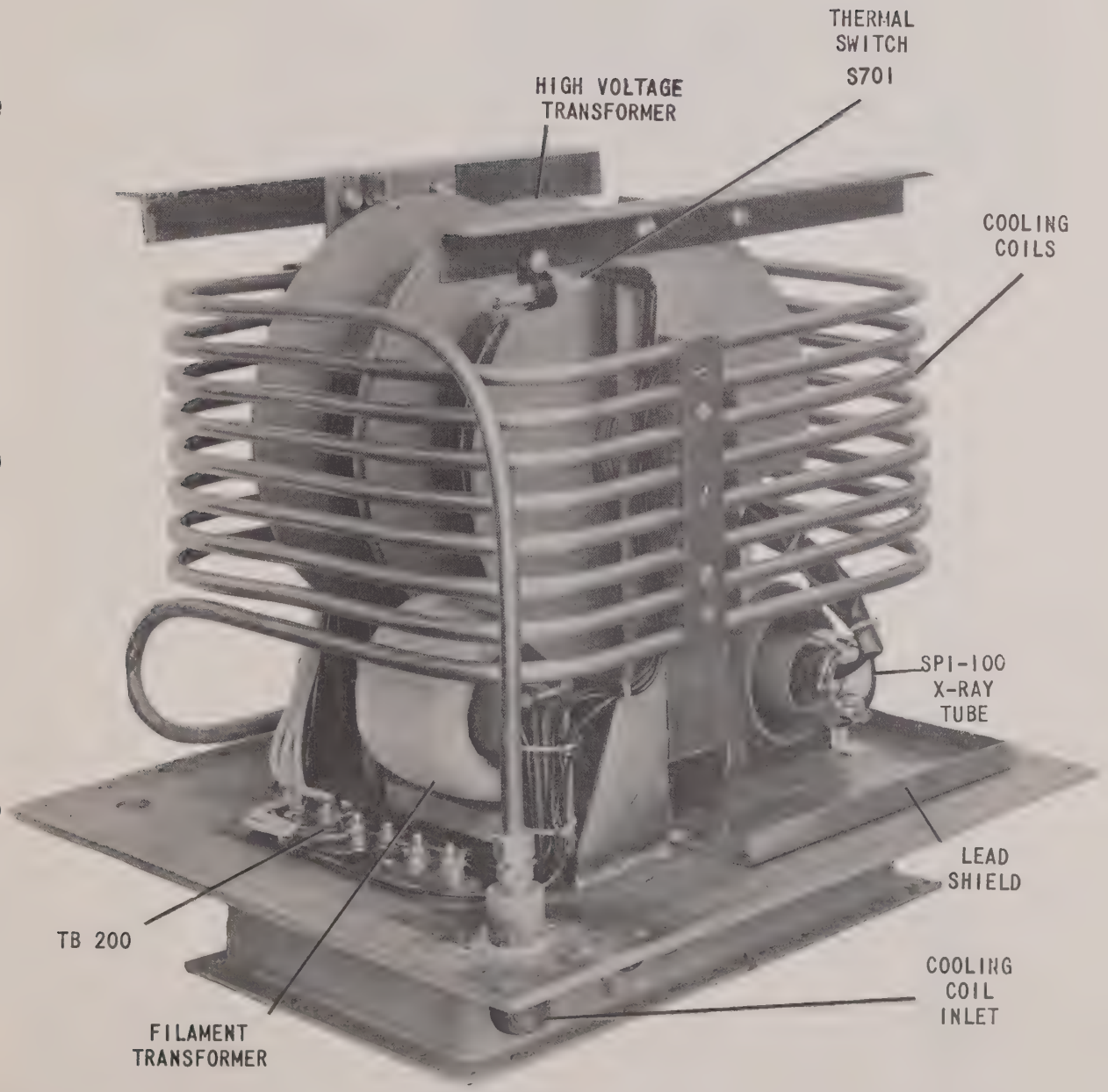
b. Remove any sediment found in the tank.

c. Flush tank with some new oil.

d. Add approximately seven gallons of GE Type 917 oil to the tank.

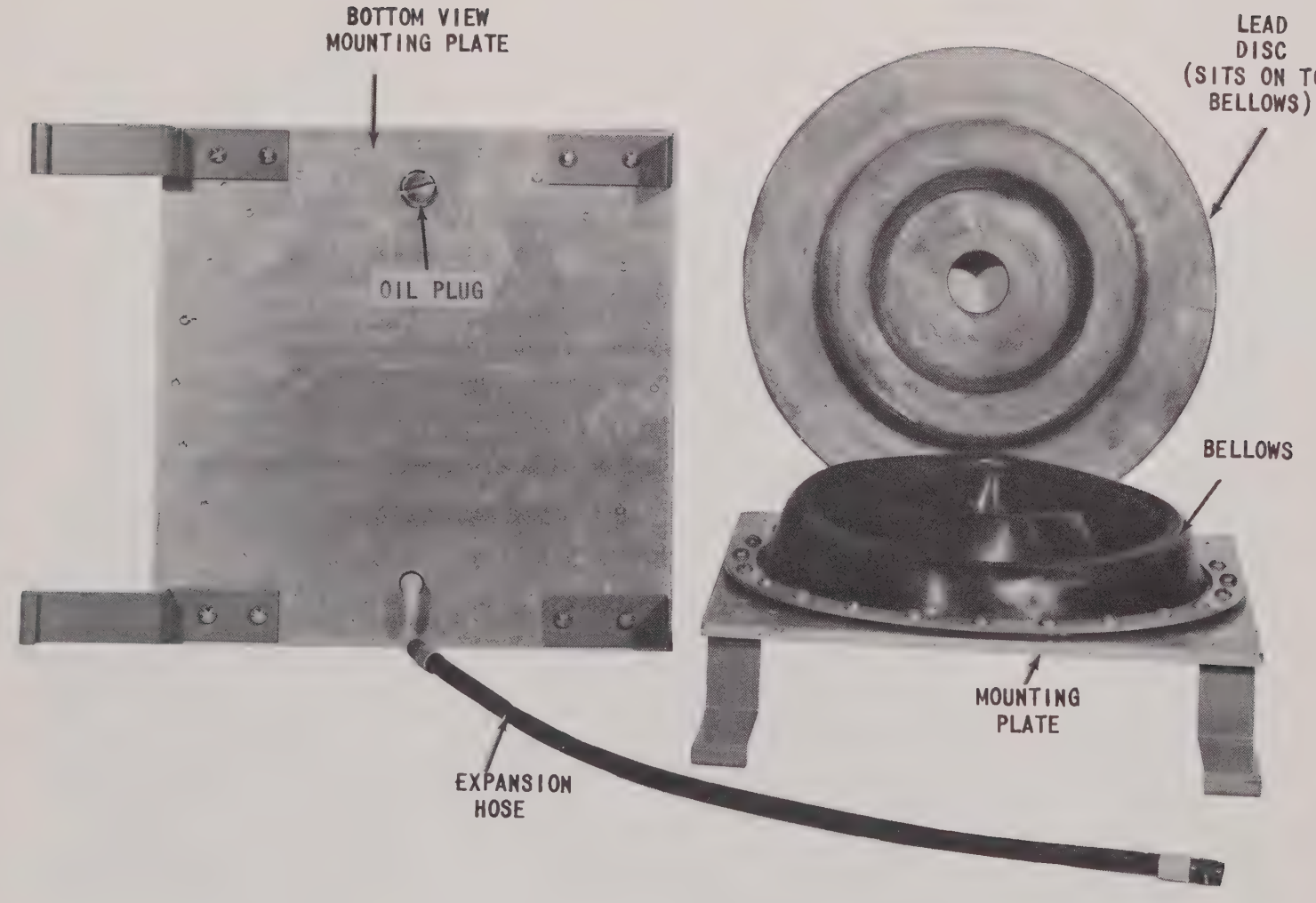
12:04 Installation of X-Ray Tube:

a. Wipe the x-ray tube with a clean, dry, lint-free cloth, using CDX 75-25 if necessary. Do not use water.



X-RAY TUBE HEAD
WITH TANK REMOVED

5039-P10



EXPANSION TANK PARTS

3783-P10

b. After the tube is clean and dry, "wet" it by immersion in new oil. The tube may be held by the anode radiator and immersed in the new oil in the tank.

c. Carefully lower the x-ray tube onto the tank cover plate positioning the tube with the holes in the lead and bakelite shield mating with the oil displacement cone.

d. Replace the screws securing the two metal clamps which fasten the x-ray tube to the tank cover plate. Tighten securely.

e. Reconnect the x-ray tube filament leads and the cathode high voltage lead which is tied in with either one of the filament leads. CAUTION: Be sure connections are secure. Dress these leads to allow approximately one inch clearance between the bottom water cooling coil and the cathode end of the lead shield around the x-ray tube. Reinsulate the leads.

f. Replace the screw securing the anode high voltage lead to the x-ray tube. Dress this lead to allow approximately one inch clearance from the anode end of the x-ray tube glass envelope.

12:05 Sealing the Head:

a. Apply a thin even coat of fibre grease to the tube head gasket. Wipe off excess grease.

b. Lower the transformer and x-ray tube into the tank. (The x-ray tube and the expansion tank should be at opposite ends of the main tank.)

c. Insert the cover bolts through the tube head cover plate. Turn the bolts down until they touch the cover. Tighten the bolts uniformly around the cover, 1/2 turn at a time, until they are secure.

d. Place an oil plug gasket in position and mount the oil filler tube.

e. Add new oil to the tube head through the oil filler tube until the oil level is visible at the oil fitting for the expansion tank hose.

f. Plug the head oil fitting for the expansion tank hose.

g. Agitate the head to allow entrapped air to escape through the oil filler tube.

Add oil as necessary to maintain a visible oil level in the filler tube.

This operation is complete when there are no more air bubbles seen rising in the oil filler tube.

h. Insert a pointed wood dowel into the oil filler tube, sealing the tube off to prevent spilling oil during its removal.

Carefully remove the oil filler tube with the oil it contains. Remove the oil filler plug gasket.

i. Wipe the filler plug sealing surface, and place a new gasket in position. Replace and tighten oil plug securely.

j. Remove the oil expansion tank from the tube head.

k. Remove the oil plug from the oil expansion tank and the clamp from the expansion tank hose, and drain the oil expansion tank.

l. Install the oil filler tube and gasket in the oil filler plug opening of the expansion tank.

m. Support the expansion tank base plate so that the bellows hangs free and the oil filler tube is up. Support the free end of the expansion tank hose at least two inches above the base plate.

n. Add oil to the expansion tank in accordance with the following schedule:

Ambient Room Temp. in Degrees Fahrenheit	Pints of Oil in Expansion Tank
40	3/4
50	1
60	1-1/4
70	1-1/2
80	1-3/4
90	2
100	2-1/4
110	2-1/2
120	2-3/4

Lower the bellows against a flat surface to compress it until oil just begins to flow out of the free end of the expansion tank hose.

Attach a pinch clamp firmly to the hose approximately one inch from the free end fitting, and remove oil filler tube.

o. Reinstall the expansion tank on the tube head.

Unplug the head oil fitting for the expansion tank hose.

Reconnect the expansion tank hose to the head oil fitting and remove the pinch clamp.

p. Tip the tube head up into position on the base brackets.

q. Replace the lead bellows compression disk, forming the bellows so that it conforms with the shape of the compression disk.

r. Replace the oil expansion tank cover.

s. Reconnect all the leads to the tube head and phototube chassis terminals. (Check spark gap .032 inch, and grounding strip.)

Temporarily block the x-ray beam with suitable material to minimize danger from radiation during the following tests.

t. Reconnect unit to power source.

12:06 Tests and Adjustments:

a. NOTE: Normally it would be desirable to let the tube head stand for 24 hours before energizing unit for final test. However, the unit may be readied for immediate operation by gradually energizing the transformer to liberate any air. The object is to generate heat without arcing until the transformer can be operated at full voltage.

b. Make sure unit is properly grounded before attempting operation.

c. Turn the primary voltage variac and the filament control fully counterclockwise.

d. Energize unit by turning line ON-OFF switch ON. (Red light on control panel lights.)

e. After the automatic 60 second time delay period, turn the x-ray ON-OFF switch ON. (Green light on control panel lights.)

f. While observing the voltmeter indicating the high voltage transformer primary voltage, turn the variac clockwise until the voltmeter indicates 50 volts.

g. Gradually turn the filament control clockwise until a reading of approximately 2 ma is obtained on the ma meter.

Listen carefully at the tube head for sounds of arcing. The ma meter may indicate this condition by erratic behavior.

If arcing occurs, de-energize the unit immediately and repeat agitating unit.

h. Repeat operation of unit, gradually raising the kvp and ma, until the unit can be operated continuously at 100 kvp, 5 ma. (110 volts on the primary voltmeter results in approximately 100 kvp across the x-ray tube.)

i. Repeat head agitation at any point where arcing occurs and resume operation at technics where unit last operated without arcing.

j. When the tube head successfully passes high voltage operation without indications of arcing, de-energize the unit.

k. Replace the four rods securing the tube head to the base bracket. Tighten securely.

l. Repeat Tests and Adjustments as outlined in Section 9.00 and subsequent sections of this manual.

Symbol	Cat. No.	Description	Function
B101	T1050G	Hour Clock, G.E. Co. #500X13, Model 8KT903	Records total time of operation of equipment.
B401(29, W)	1004256P2	Counter, Durant Mfg. Co., Model 6-Y-1-MF-S with reset knob	Records total number of rejections by its amplifier chassis.
B501	34-1745	Fan	Provides air circulation within control to prevent localized heating.
C101	T0834CE	Capacitor, 0.1 mfd, 400 wvdc, Aerovox PBB	Averages out the rapid fluctuations in x-ray tube current through the ma meter M102.
C102	T0834CP	Capacitor, 2 mfd, 450 wvdc, Sprague TVA-1701	Averages out the current pulses through R105 and R106 to produce a voltage proportional to the operating ma.
C103	T0834CE	Capacitor, 0.1 mfd, 400 wvdc, Aerovox PBB	Averages out the rapid fluctuations in primary voltage applied to primary voltmeter M101.
C104	T0834CE	Capacitor, 0.1 mfd, 400 wvdc, Aerovox PBB	Averages out the surges across the contacts of filament stabilizing relay R102.
C301(4, M)	T0834CF	Capacitor, 0.001 mfd, 600 wvdc	By-passes noise signals from input of crystal cathode follower stage V301B to ground.
C302(3, M)	T0834CF	Capacitor, 0.001 mfd, 600 wvdc	By-passes noise signals from input of crystal cathode follower stage V301A to ground.

Symbol	Cat. No.	Description	Function
C303(11, N)	T0834FP	Capacitor, 0.22 mfd, molded tubular	Provides by-pass to ground for any oscillations which might otherwise occur in shutter relay stage V303.
C401(28, C, J) (29, C)	T0834BW	Capacitor, 10-10-10 mfd, 475 wvdc, 85°C electrolytic, Mallory FP-23	Provides filtering for +255 vdc supply and +105 vdc supplies.
C402(M, 28)	58-272	Capacitor, 10-10 mfd, 450 wvdc, 85°C electrolytic, Mallory FP-23	Provides filtering for -75 vdc supply voltage.
C403(11, N)	T0834QX	Capacitor, 0.1 mfd, 1000 vdc, Cornell Dublier TWC 10 P1	Provides screen grid by-pass for second amplifier stage V408.
C404(7, K)	T0834BZ	Capacitor, 0.05 mfd, 600 wvdc, 85°C, moisture proof, molded tubular, Mallory PT615	Coupling capacitor which blocks the d-c portion of the signal applied to grid of first amplifier stage V407.
C405(9, N)	T0834QX	Capacitor, 0.1 mfd, 1000 vdc, Cornell Dublier TWC 10 P1	Provides screen grid by-pass for first amplifier stage V407.
C406(13, G)	T0834CA	Capacitor, 0.1 mfd, 600 wvdc, high temperature, metallized paper, Aerovax PT610	Coupling capacitor to grid of third amplifier stage V410.
C407(9, G)	T0834GB	Capacitor, 0.005 mfd, 600 wvdc, 85°C, moisture proof, molded tubular, Mallory PT611	Coupling capacitor to grid of second amplifier stage V408.
C408(7, 13, 20, C)	T0834BW	Capacitor, 10-10-10 mfd, 475 wvdc, 85°C electrolytic, Mallory FP-23	Provides filtering for plate and screen grid supplies for three amplifier stages fill detection stage and reject multivibrator stage.
C409(31, C)	T0834CB	Capacitor, 0.01 mfd, 600 wvdc, 85°C, moisture proof, molded tubular, Mallory PT611	Provides line voltage filtering across input of power transformer T401.

Symbol	Cat. No.	Description	Function
C410(31, E)	T0834CB	Capacitor, 0.01 mfd, 600 wvdc, 85°C moisture proof, molded tubular, Mallory PT611	Provides line voltage filtering across input of power transformer T401.
C411(20, M)	T0834CC	Capacitor, 0.001 mfd, 600 wvdc, Mallory PT621	Plate to grid coupling capacitor for two halves of fill detection multivibrator stage V412.
C412(20, J)	T0834CC	Capacitor, 0.001 mfd, 600 wvdc, Mallory PT621	Plate to grid coupling capacitor for two halves of fill detection multivibrator stage V412.
C413(18, R)	T0834CC	Capacitor, 0.001 mfd, 600 wvdc, Mallory PT621	Coupling capacitor transmits signal from reject pulse forming stage V414 to reject multivibrator stage V415.
C414(18, Q)	T0834CC	Capacitor, 0.001 mfd, 600 wvdc, Mallory PT621	Coupling capacitor transmits signal from reject pulse forming stage V414 to fill detection stage V412.
C415(23, D)	T0834EB	Capacitor, 0.05 mfd, 400 wvdc, Aerovox P82	Plate to grid coupling capacitor for two halves of reject multivibrator stage V415.
C416(G, 10)	T0834CD	Capacitor, 100 mmfd, 500 wvdc, 85°C, tubular ceramic, Mallory UC-531	Provides high frequency feedback in second amplifier stage V408 which suppresses noise signals developed in preceding stages of detector.
C417(8, N)	T0834CC	Capacitor, 0.001 mfd, 600 wvdc, Mallory PT621	In conjunction with R445 provides noise filter in grid circuit of first amplifier stage V407.
C418(31, V)	T0834CQ	Capacitor, 0.2 mfd, 600 wvdc, 85°C, moisture proof, molded tubular, Mallory PT602	Averages out surges across contacts of reject relay RE401, minimizing pitting and burning of contacts.

Symbol	Cat. No.	Description	Function
C420(22, T) C421(22, U)	T0834AT	Capacitor, 0.5-0.5 mfd, 600 wvdc, G.E. #23F532	Averages out surges across contacts of reject relay RE401, minimizing pitting and burning of contacts.
CH401(28, B)	T1036J	Choke, Thordarson Type T-20C53	Provides filtering for +255 vdc and +105 vdc power supplies.
CH402(29, L)	59-493	Choke, Thordarson Type T-49131	Provides filtering for -75 vdc power supply.
F101	T0202T	Fuse, set of 5, 15-a, 250-v, 3AB, Littlefuse #314015	Provides protection for 115 vac line supply.
F102	T0202T	Fuse, set of 5, 15-a, 250-v, 3AB, Littlefuse #314015	Provides protection for 115 vac line supply.
F103	T0202C	Fuse, set of 5, 3-a, 250-v, 3AG, Littlefuse #312003	Provides protection for x-ray control and amplifier circuits.
F104	T0202C	Fuse, set of 5, 3-a, 250-v, 3AG, Littlefuse #312003	Provides protection for x-ray tube filament primary circuit.
F105	T0202C	Fuse, set of 5, 3-a, 250-v, 3AG, Littlefuse #312003	Provides protection for x-ray control and amplifier circuits.
F401(31, M)	T0202F	Fuse, set of 5, 2-a, 250-v, 3AG, Littlefuse #312003	Provides protection for electronic chassis.
HTR101	T0229G	Heater, G.E. Cat. No. 9708G	Provides protection for high voltage primary circuit of x-ray generator.
I101	59-298	Lamp, 115-v, 6-w, G.E. #S-6	Indicates x-ray generator is in STAND-BY condition.

Symbol	Cat. No.	Description	Function
I102	59-298	Lamp, 115-v, 6-w, G.E. #S-6	Indicates x-ray generator is in OPERATE condition.
I301	T0035E	Lamp, 6.3-v, 1/3-a, G.E. #44, bayonet base	Provides light source for phototube gating circuit.
I701(15, C)	T0035AX	Lamp, neon, set of 6, NE-2-T2	Indicates operation of three amplifier stages during test operation of CRYSTAL test switch S701.
LS501	T0779Y	Stabilizer, 115-v, 60-cy, 500 VA, Raytheon VR-6115	Connected in parallel with LS502 to provide line voltage stabilization for Hytafill circuits.
LS502	T0779Y	Stabilizer, 115-v, 60-cy, 500 VA, Raytheon VR-6115	Connected in parallel with LS501 to provide line voltage stabilization for Hytafill circuits.
M101	3000322P31	Voltmeter, G.E. #8A072V5BA1	Reads primary voltage to high voltage transformer T202, the magnitude of which is determined by the setting of the variac T101.
M102	3000322P32	Milliammeter, G.E. #800T1A5BE2	Reads milliamperes through x-ray tube, the magnitude of which is determined by the setting of the FILAMENT CONTROL, R101 and R105.
P401(6, K)	58-289	Potentiometer, 10k, 2-w, Allen-Bradley JLU-1031, S04040L	Provides adjustable GAIN control for input to first amplifier stage V407 and acts as cathode resistor for crystal cathode follower stage V301.
P404(17, S)	T0755AA	Potentiometer, 100k, 2-w, Allen-Bradley JLU-2552, S04040L	Provides adjustable REJECT control by providing method of varying grid bias to

Symbol	Cat. No.	Description	Function
			one-half of reject pulse forming stage V414B.
P405(23, F)	T0755AA	Potentiometer, 100k, 2-w, Allen-Bradley JLU-2552, S04040L	Provides adjustable TIME control which determines the length of time a reject action is sustained by varying the grid leak resistance of one-half of the reject multivibrator V415B.
R101	T0199L	Potentiometer, 125 ohms, 50-w, Ohmite Model J Code JACOR #0320	Provides a variable resistance in the x-ray tube filament primary circuit which controls the temperature of the filament and thus the tube current through the x-ray tube.
R102	58-190	Resistor, 40 ohms, 10-w, Ohmite Brown Devil	Limits current through primary of x-ray tube filament transformer T201 to proper range of values for correct operation.
R103	T0093EJ	Resistor, 100 ohms, 20-w, Ohmite Brown Devil	Provides added resistance in primary circuit of x-ray tube filament transformer when contact RE102-1 of filament stabilizing relay opens, causing x-ray tube current to decrease.
R104	T0093DY	Resistor, 15 ohms, 10-w, IRC	Provides resistance in primary circuit of high voltage transformer T202 when x-ray contactor contact RE101-2 closes circuit, preventing high surges. R104 is shorted out when RE101-1, contact with greater spacing, closes after initial surges have been suppressed.
R105	1004980P1	Potentiometer, 100k, 2-w	Together with R106 develops a voltage proportional to x-ray tube current at the

Symbol	Cat. No.	Description	Function
			value determined by the setting of R101. R105 is mechanically linked to R101.
R106	T0093DP	Resistor, 15k, 2-w, ±10% carbon	Together with R105 develops a voltage proportional to x-ray tube current at the value determined by the setting of R101.
R107	58-259	Resistor, 100 ohm, 1-w, ±10% carbon	Provides surge suppression across contacts of RE102, minimizing pitting of contacts.
R301(5, M)	T0093DZ	Resistor, 330k, 1-w, ±10% carbon	Provides grid-leak path for crystal cathode follower stage V301B.
R302(3, M)	T0093D	Resistor, 330k, 1-w, ±10% carbon	Provides grid-leak path for crystal cathode follower stage V301A.
R303(12, T)	T1084G	Resistor, 820k, 1-w, ±10% carbon	Part of voltage divider that develops grid bias for V303B.
R304(13, T)	T0093BG	Resistor, 10k, 1-w, ±10% carbon	Cathode resistor for phototube cathode follower V302A.
R305(13, P)	T1084P	Resistor, 100k, 1-w, ±10% carbon	Limits grid current of V303B when potential across R304 becomes large enough to drive grid of V303B positive.
R306(14, P)	T0093EA	Resistor, 20 meg, 2-w, ± 5%: Continental Carbon, Nobeloy X2	Together with phototube V304 forms a voltage divider that develops grid bias for phototube cathode follower stage V302A.
R307(12, L)	T0093EB	Resistor, 1 meg, 1-w, ± 10% carbon	Part of voltage divider that develops grid bias for V303A.

Symbol	Cat. No.	Description	Function
R401(7, A)	T0093BG	Resistor, 10k, 1-w, ±10% carbon	Provides filtering for +255 vdc supply applied to crystals X301 and X302 and first amplifier stage V407.
R402(25, E)	T0093DK	Resistor, 15k, 10-w, ±10%	Provides a shunt across regulator tube V405 to reduce the current through V405 to a safe value.
R403(28, G)	T0093BC	Resistor, 5k, 10-w, ±10%	Provides filtering for +105 vdc supply for shutter relay stage V303 and reject relay stage V411.
R404(28, G)	T1086A	Resistor, 3.5k, 10-w, ±10%	Provides filtering for +105 vdc supply for shutter relay stage V303 and reject relay stage V411.
R405(27, B)	T0180AS	Resistor, 1k, 10-w, ±10%	Provides filtering for +255 vdc supply.
R406(26, L)	T0180AT	Resistor, 6k, 10-w, ±10%	Provides filtering for -75 vdc supply.
R407(9, O)	T0093ER	Resistor, 470 ohm, 1-w, ±10% carbon	Provides cathode bias for first amplifier stage V407.
R408(7, O)	T1083T	Resistor, 1 meg, 1/2-w, ± 10% carbon	Grid-leak for first amplifier stage V407.
R409(8, D)	T0093L	Resistor, 33k, 1-w, ±10% carbon	Plate load for first amplifier stage V407.
R410(9, D)	T1084P	Resistor, 100k, 1-w, ±10% carbon	Screen grid dropping resistor for first amplifier stage V407.
R411(11, A)	T0093BG	Resistor, 10k, 1-w, ±10% carbon	Provides filtering for +255 vdc supply applied to second and third amplifier stages, V408 and V410.

Symbol	Cat. No.	Description	Function
R412(10, J)	T0093CE	Resistor, 68k, 1/2-w, ±10% carbon	Part of grid-leak for second amplifier stage V408.
R413(9, O)	T1083P	Resistor, 220k,, 1/2-w, ±10% carbon	Part of grid-leak circuit for second amplifier stage V408.
R414(10, O)	T0093ER	Resistor, 470 ohm, 1-w, ±10% carbon	Cathode bias resistor for second amplifier stage V408.
R415(10, D)	T0093L	Resistor, 33k, 1-w, ±10% carbon	Plate load resistor for second amplifier stage V408.
R416(11, D)	T1084P	Resistor, 100k, 1-w, ±10% carbon	Screen grid dropping resistor for second amplifier stage V408.
R417(15, J)	T0093BD	Resistor, 470k, 1/2-w, ±10% carbon	In conjunction with R418 acts as grid-leak for third amplifier stage V410 whenever positive signal is applied.
R418(15, O)	T1084T	Resistor, 22k, 1-w, ±10% carbon	In conjunction with R419 forms a voltage divider between -75 vdc and ground, maintaining a fixed bias on third amplifier stage V410 of -18 vdc.
R419(15, U)	T1084D	Resistor, 68k, 1-w, ±10% carbon	In conjunction with R418 forms a voltage divider between -75 vdc and ground, maintaining a fixed bias on third amplifier stage V410 of -18 vdc.
R420(16, J)	T0093EQ	Resistor, 470k, 1-w, ±10% carbon	Part of grid-leak circuit for third amplifier stage V410.
R421(16, D)	T1084P	Resistor, 100k, 1-w, ±10% carbon	Plate load resistor for third amplifier stage V410.

Symbol	Cat. No.	Description	Function
R422(17, D)	T1084P	Resistor, 100k, 1-w, ±10% carbon	Screen grid dropping resistor for third amplifier stage V410.
R423(19, E)	T1084P	Resistor, 100k, 1-w, ±10% carbon	Plate load resistor for one-half of fill detection stage V410.
R424(21, E)	T1084P	Resistor, 100k, 1-w, ±10% carbon	Plate load resistor for one-half of fill detection stage V412B.
R425(20, L)	T1083T	Resistor, 1 meg, 1/2-w, ± 10% carbon	Plate to grid coupling resistor for two halves of fill detection multivibrator V412.
R426(20, J)	T1083T	Resistor, 1 meg, 1/2-w, ± 10% carbon	Plate to grid coupling resistor for two halves of fill detection multivibrator V412.
R427(19, U)	T0093CC	Resistor, 680k, 1/2-w, ±10% carbon	Grid bias resistor for one-half of fill detection multivibrator V412.
R428(20, U)	T0093CC	Resistor, 680k, 1/2-w, ±10% carbon	Grid bias resistor for one-half of fill detection multivibrator V412.
R429(20, Q)	T0093DT	Resistor, 820k, 1/2-w, ±10% carbon	Part of voltage divider connected between -75 vdc and +255 vdc which affects the grid bias voltage applied to the fill detection multivibrator V412.
R430(20, U)	T0093CC	Resistor, 680k, 1/2-w, ±10% carbon	Part of voltage divider connected between -75 vdc and +255 vdc which affects the grid bias voltage applied to the fill detection multivibrator V412.
R431(21, R)	T0093AJ	Resistor, 2.2 meg, 1/2-w, ± 10% carbon	Couples output of fill detection stage V412 to reject multivibrator V415.

Symbol	Cat. No.	Description	Function
R432(17, K)	T1084D	Resistor, 68k, 1-w, ±10% carbon	Part of plate load for reject pulse forming stage V414A and part of voltage divider for REJECT adjustment P404.
R433(17, U)	T0093AP	Resistor, 15k, 1-w, ±10% carbon	Cathode bias resistor for reject pulse forming stage V414.
R434(17, O)	T0093R	Resistor, 150k, 1-w, ±10% carbon	Part of plate load for reject pulse forming stage V414A.
R435(20, A)	T0093BG	Resistor, 10k, 1-w, ±10% carbon	Provides filtering for +255 vdc supply to fill detection stage V412 and reject multivibrator V415.
R436(19, P)	T1083T	Resistor, 1 meg, 1/2-w, ± 10% carbon	Provides charging path for coupling capacitor C414.
R437(22, B)	T1084P	Resistor, 100k, 1-w, ±10% carbon	Plate load for one-half of reject multivibrator V415.
R438(23, B)	T1084P	Resistor, 100k, 1-w, ±10% carbon	Plate load for one-half of reject multivibrator V415.
R439(23, C)	T0093EQ	Resistor, 470k, 1-w, ±10% carbon	Plate to grid coupling resistor for two halves of reject multivibrator V415.
R440(23, E)	T0093R	Resistor, 150k, 1-w, ±10% carbon	In conjunction with P405 TIME control, provides grid-leak resistance for one-half of reject multivibrator V415B.
R441(22, L)	T0093DT	Resistor, 820k, 1/2-w, ±10% carbon	Provides grid bias for one-half of reject multivibrator V415A.
R442(25, F)	T0093CC	Resistor, 680k, 1/2-w, ±10% carbon	Provides coupling from plate of reject multivibrator V415B to grid of reject relay stage V411.

Symbol	Cat. No.	Description	Function
R443(25, U)	T0093Q	Resistor, 270k, 1-w, ±10% carbon	Part of voltage divider that provides bias for grid of reject relay stage V411.
R444(17, U)	T1084P	Resistor, 100k, 1-w, ±10% carbon	Provides coupling from phototube cathode follower or from test circuits to grid of reject pulse forming stage V414.
R445(8, K)	T1083P	Resistor, 220k, 1/2-w, ±10% carbon	Part of grid leak circuit for first amplifier stage V407.
R446(17, O)	T1084P	Resistor, 100k, 1-w, ±10% carbon	Part of voltage divider that provides screen grid voltage for third amplifier stage V410.
R701(6, M)	T0093BD	Resistor, 470k, 1/2-w, ±10% carbon	Part of voltage divider between 6.3 vac winding of T401 and ground to provide test voltage for CRYSTAL switch S701.
R702(6, M)	T0093HZ	Resistor, 10k, 1/2-w, ±10% carbon	Part of voltage divider between 6.3 vac winding of T401 and ground to provide test voltage for CRYSTAL switch S701.
R703(16, R)	T0093FS	Resistor, 5.6k, 1-w, ±10% carbon	Part of voltage divider between -75 vdc supply and ground to provide test voltage for PHOTOTUBE switches S702 and S703.
R704(16, T)	T0093GL	Resistor, 330k, 1/2-w, ±10% carbon	Part of voltage divider between -75 vdc supply and ground to provide test voltage for PHOTOTUBE switches S702 and S703.
R705(15, E)	T1083P	Resistor, 220k,, 1/2-w, ±10% carbon	In conjunction with I701 is voltage divider connected across plate load resistor of third amplifier stage V410 and prevents conduction of I701 from shorting plate load of V410.

Symbol	Cat. No.	Description	Function
RE101	1003793P3	Relay, 95-125 vac, 50-60-cycle	X-ray contactor controls application of power to high voltage primary circuit. RE101 operates when time delay relay TDRE103 closes.
RE102	T0156AZ	Micro-Positioner, Barber-Colman Co., single coil, 8200 ohms, silver contacts, Code 43-17000, Type O, sensitivity 0.97	Current sensitive relay changes resistance in series with primary of filament transformer T201 once each cycle, thus maintaining constant tube current.
RE301(12, L) RE302(13, L)	1003679G1	Relay Assembly Shutter	Consists of top shutter coil RE301 and bottom shutter coil RE302 which move armature in and out of x-ray beam in accordance with gating signal received by shutter relay stage from phototube cathode follower.
RE401(25, K)	1003793P4	Relay, 6200 ohms, 2 sets of contacts rated at 5-a, 115 vac	Coil is plate load of reject relay stage. Contacts operate counter B401 and customer's reject mechanism.
S101	T0014Q	Switch, flush tumbler, DPST, G.E. #2847	Applies 115 vac line voltage to Hytafill unit.
S102	T0014B	Switch, less heater, G.E. Type CR1061-H2A	Applies voltage to x-ray contactor RE101 and primary of high voltage transformer T202.
S201	T0001AW	Thermostat, Thomas A. Edison, Type D8-2AN1C, Temp. adj. 71°C, ±2-1/2°C, with mounting clamp	Interrupts power to x-ray contactor when tube head temperature rises above safe operating point.
S401(20, O)	59-679	Switch, DPDT, Arrow, Hart & Hegeman #81027-CE	OVERFILL-UNDERFILL switch that selects the condition of fill that will result in rejection of containers.

Symbol	Cat. No.	Description	Function
S701(6, K)	59-688	Switch, DPDT, Spring action, Arrow, Hart & Hegeman #21858-J	CRYSTAL switch that connects approximately 0.1 vac to the grid of the first amplifier stage V407, simulating a crystal signal.
S702(15, U)	59-688	Switch, DPDT, Spring action, Arrow, Hart & Hegeman #21858-J	PHOTOTUBE spring switch that connects -75 vdc test voltage to grid of reject pulse forming stage V414A, simulating full light beam on phototube.
S703(16, S)	59-556	Switch, push button, Grayhill #2201	PHOTOTUBE push button switch that completes circuit through voltage divider between -75 vdc supply and ground applying approximately -1.3 vdc to grid of reject pulse forming stage V414A, simulating container blocking light to phototube.
T101	T1144A	Variac, Superior Electric Co., Powerstat Type 1126	Provides continuous variation of voltage applied to primary winding of high voltage transformer T202, thus varying kvp applied across x-ray tube V201.
T201	Parts listed separately.	Transformer, x-ray tube filament	Provides proper voltage to heat filament of x-ray tube V201.
T202	Parts listed separately.	Transformer, high voltage	Supplies kvp applied across x-ray tube V201.
T401(30, D, R)	T1087R	Transformer, Thordarson Type T22-R32	Power transformer that supplies voltages required for amplifier and phototube chassis.
TDRE103	T0156CB	Time Delay Relay, Amperite #115NO30T	Prevents application of voltage to x-ray contactor RE101 until thirty seconds after the LINE switch S101 is energized.

Symbol	Cat. No.	Description	Function
V201	D0032C	X-Ray Tube, SPI-100	Provides x-radiation necessary to penetrate containers.
V301(3, 4, J)	T0557CX	Tube GL5814A (12AU7)	Cathode follower for crystal output signal.
V302(13, O)	T0557CX	Tube GL5814A (12AU7)	Cathode follower for phototube output signal.
V303(12, 13, M)	T0557CX	Tube GL5814A (12AU7)	Shutter relay stage which operates when a container enters or leaves the inspection position.
V304(14, T)	T0557CH	Phototube, 5583	Provides signal to grid of phototube cathode follower V302, the intensity of which is dependent on the quantity of light striking V304.
V401(30, B)	T0557CT	Tube, GL6087 (5X3)	Power supply rectifier for +255 vdc and +105 vdc supplies.
V402(30, M)	T0557CW	Tube, GL6202 (6X4)	Power supply rectifier for -75 vdc supply.
V403(26, J)	59-759	Tube, OB2 (VR105)	Voltage regulator for +105 vdc supply for crystal and phototube cathode followers.
V404(27, J)	59-759	Tube, OB2 (VR105)	Voltage regulator for +105 vdc supply to shutter relay and reject relay stages.
V405(26, E)	T0756E	Tube, OA2 (VR150)	In conjunction with V403 provides voltage regulation for +255 vdc supply.
V406(26, N)	T0557CJ	Tube, OA3 (VR75)	Voltage regulator for -75 vdc supply.
V407(8, J)	T0557CZ	Tube, JL6136 (6AU6)	First amplifier stage for crystal signal.

Symbol	Cat. No.	Description	Function
V408(10, J)	T0557CZ	Tube, GL6136 (6AU6)	Second amplifier stage for crystal signal.
V409(14, L) (18, F)	T0557CY	Tube, GL5726	V409A provides voltage clamping preventing the grid of V410 from becoming more negative than -18 volts. V409B allows negative going (decreasing) plate voltages at V410 to be relected into the plate circuit of V412A, acting as a trigger.
V410(16, M)	T0557CZ	Tube, GL6136 (6AU6)	Third amplifier stage for crystal signal.
V411(25, N)	T0557CX	Tube, GL5814A (12AU7)	Operates reject relay when trigger signal appears at its grid causing conduction.
V412(19, 21, O)	T0557CX	Tube, GL5814A (12AU7)	Fill detection multivibrator which changes its state of conduction depending on the signals received from the third amplifier stage V410 and the reject pulse forming stage V414.
V413(19, 22, O)	T0557CY	Tube, GL5726	Controls the polarity of voltages allowed to be impressed on the grids of the fill detection multivibrator V412A and the reject multivibrator V415A.
V414(17, 18 S)	T0557CX	Tube, GL5814A (12AU7)	Reject pulse forming multivibrator which changes its state of conduction depending on the signals received from the phototube cathode follower V302A.
V415(22, 23, E)	T0557CX	Tube, GL5814A (12AU7)	Reject multivibrator which changes its state of conduction depending on the signals received from the reject pulse forming stage V414 and the fill detection stage V412.

Symbol	Cat. No.	Description	Function
X301(4, E)	507A815G1	Crystal, single channel	X-ray sensitive crystal which detects the amount of absorption experienced by the x-ray beam in passage from x-ray tube to crystal.
X302(4, E)	1003819G1	Crystal, dual channel	

14:00 TROUBLE-SHOOTING SECTION

14:01 Preliminary Information

a. Before using this trouble-shooting chart, reference should be made to the emergency trouble-shooting chart in Appendix III, Direction 12377. When using either chart, do not forget to check the obvious things, such as blown fuses, open vacuum tube filaments, loose screw connections, or controls out of adjustment. Also, before spending time in trouble-shooting it is desirable to actually weigh a representative number of rejected and accepted containers in order to determine that the Hytafill is actually at fault.

b. Remember to make use of spare amplifiers when available for aid in localizing trouble. In addition, even single channel units have two crystal cathode follower circuits, either one of which may be utilized with minor reconnections.

c. When first attempting to service the unit, a thorough check of the operational adjustments is usually worth while. If the test circuits are fully utilized, it may be possible to localize trouble to certain portions of the electronic circuits almost immediately. If operation is found to be erratic, particularly if too many acceptable containers are being rejected, an initial check may be made by dropping the level of the tube head an inch or so, so that all containers will be seen as filled. If the Hytafill then does not reject any containers that are not actually below this fill level (there should be very few), the trouble is external to the unit and the conveyor system as a whole should be thoroughly checked. If, however, rejection is still erratic, the trouble is definitely within the Hytafill.

14:02 Trouble Shooting Chart

Symptom	Component	Fault	Check	Remedy
1. Control circuits dead	F101, F102	Fuse blown	Continuity through removed fuse	Replace
	S101	Defective	Continuity	Replace
2. Control circuits dead but blower operates	LS501, LS502	Defective	Voltage across TB500-23 and TB500-40	Replace
3. Voltmeter reads but no red light	I101	Burned out	Substitute spare	Replace
	F103, F105	Fuse blown	Continuity through removed fuse	Replace
4. Red light and voltmeter okay but no green light or tube current	I102	Burned out	Substitute spare	Replace
	TDRE103	Defective	Substitute spare or short contacts	Replace
	S102A	Defective	Continuity	Replace
5. No tube current at any setting of filament control	F104	Fuse blown	Continuity through removed fuse	Replace
	RE101	Coil open	Continuity	Replace
	S201	Open	Continuity from TB500-23 to TB500-24 with control leads disconnected	Check head temperature. If within limits replace thermal switch
	RE102	Coil open	Continuity from pins 1 to 3 on relay	Replace
		Contacts dirty	Remove cover and inspect visually	Clean with business card
	R102	Open	Resistance measurement	Replace

Symptom (Continued)	Component	Fault	Check	Remedy
5. No tube current at any setting of filament control	T201	Defective	Voltage and current measurements from TB200-P1 to TB200-F2	Replace
	S102B	Defective	Continuity	Replace
	HTR101	Open	Continuity	Replace
	T202	Defective	Voltage and current measurements from TB200-P1 to TB200-P2	Replace defective coil or components or obtain exchange tube head
	V201	Filament open	Continuity through filament contacts	Replace x-ray tube
	Surge gap at TB200-MA	Shorted to ground	Visual	Reset gap to 0.010" with feeler gage
	C101	Shorted	Continuity through disconnected capacitor	Replace
	M102	Defective	Connect test meter in series	Replace
	R105	Open	Resistance measurement (check slider contact)	Replace
	R106	Open	Resistance measurement	Replace
6. Tube current unstable, too high, or too low for normal setting of Filament Control	RE102	Coil open	Continuity from pins 1 to 3 or substitute new relay	Replace
		Contacts dirty	Remove cover and check visually	Clean
		Contacts stuck closed	Remove cover and check visually	Replace

if conditions permit, RE102 may be temporarily removed and operation continued.

Symptom (Continued)	Component	Fault	Check	Remedy
6. Tube current unstable, too high, or too low for normal setting of Filament Control	V102	Gassy	Replace	
	V201	Intermittent breakdown	Primary current measurement followed by visual inspection	Replace defective components
	T202	Intermittent breakdown	Primary current measurement followed by visual inspection	Replace defective components or obtain exchange tube head
7. No reject action obtained, x-ray control gives normal indications, I701 does not light when underfilled container is placed in beam but--				
A) Operation of S701 lights I701	RE302, if used	Shutter stuck closed	Measure crystal voltage from TB400-20 to ground with and without phototube blocked. If no change check shutter operation	Clean or replace the shutter blade.
	P401	Out of adjustment	Repeat Amplifier Adjustment Procedure, Section 10.00, Page 81, and check operation	Lock adjustments securely
	X301, X302	Low in output or out of alignment	Check voltage from TB400-20 to ground, re-align, and compare to previous reading	Replace crystal
	V301	Weak or defective	Check voltage from TB400-20 to ground, compare to previous reading	Replace tube
	Signal cable	Open	Check voltage from TB400-20 to ground, check connections and continuity through cable	Replace cable

Symptom (Continued)	Component	Fault	Check	Remedy
7. No reject action obtained, x-ray control gives normal indications, I701 does not light when underfilled container is placed in beam but--				
A) Operation of S701 lights I701	Head cable	Open	Continuity through leads to phototube chassis	Repair
B) Operation of S701 does not light I701	V407, V408, V410	Very weak or defective	Substitute new tube	Replace
	V401	Defective	Check for +255 volts at pin 2, substitute new tube	Replace
	F401	Blown	Continuity through removed fuse	Replace
	T401	Defective	Check for 340 volts a-c from pins 4 to 6 and 5 volts a-c from pins 2 to 8 of V401	Replace transformer
	C404, C406, C407	Open	Resistance measurement	Replace
	C417	Shorted	Resistance measurement	Replace
	R445, R412, R420	Open	Resistance measurement	Replace
	R407, R414	Open	Voltage on pins 5 and 6 of V407 or V408 rises to +255 volts, measure resistance from pin 7 to ground	Replace resistor

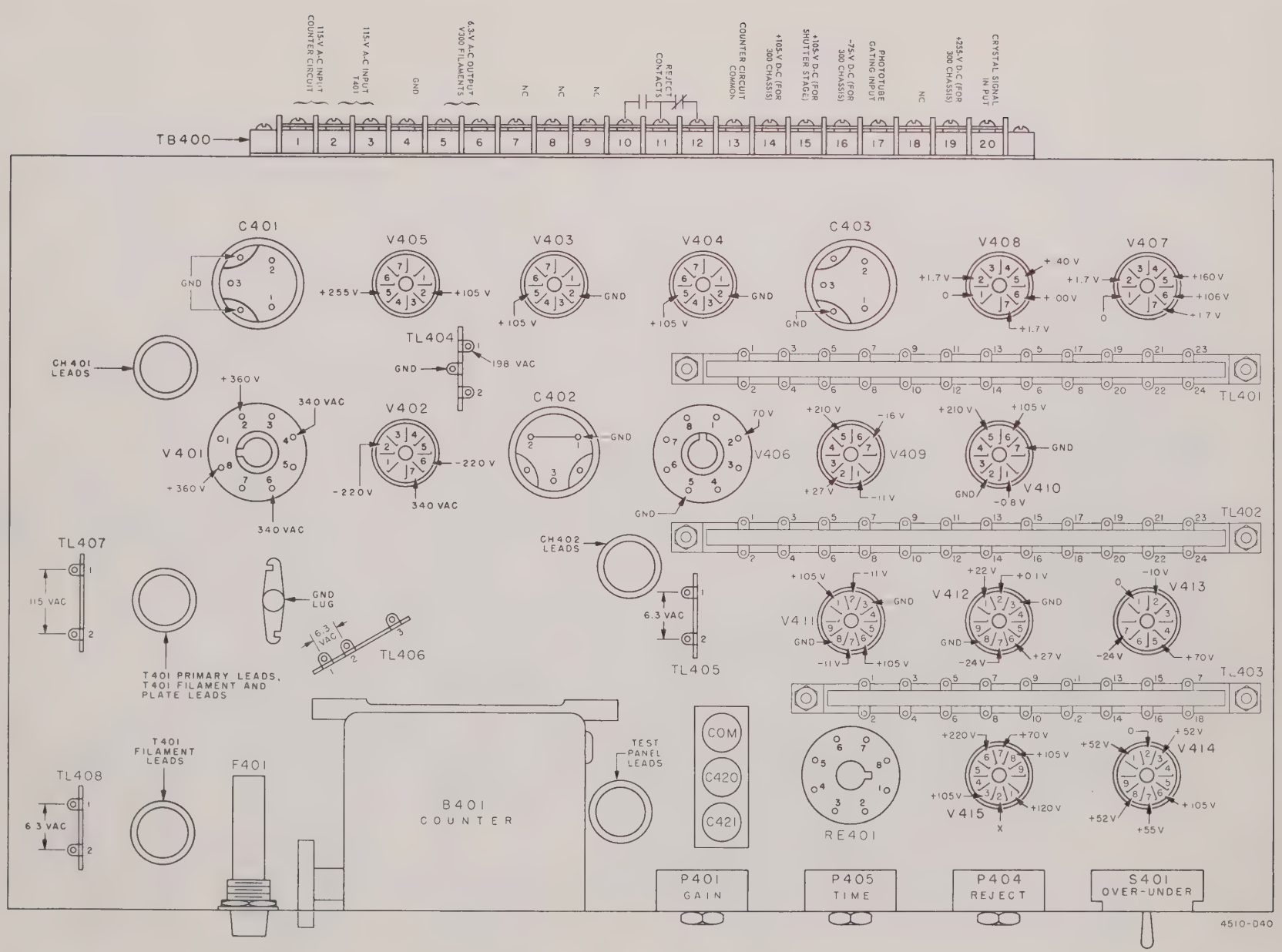
Symptom (Continued)	Component	Fault	Check	Remedy
7. No reject action obtained, x-ray control gives normal indications, I701 does not light when underfilled container is placed in beam but--				
B) Operation of S701 does not light I701	R409, R410, R415, R416 R421, R422, R401, R411, R405	Open	Check for presence of proper voltage on pins 5 and 6 of V407, V408, V410 (see Dwg. 4510-D40), measure resistance across suspected resistor	Replace resistor
8. No reject action obtained, x-ray control gives normal indications, I701 lights properly, but with S401 on Underfill--				
A) Operation of S702 and S703 produces proper reject action	I 301	Dirty or low	Clean or replace lamp	Replace
	Light source window	Dirty	Clean	Replace
	Phototube window	Dirty	Clean	Replace
	V302, V304	Low in emission, defective	If lamp and windows are okay, check voltage from TB400-17 to ground	Replace phototube or cathode follower
	Head cable	Open	Continuity through leads to phototube chassis	Repair
B) Operation of S702 and S703 produces no reject action	P404	Out of adjustment	Repeat Amplifier Adjustment Procedure, Section 10.05, Page 82 and check operation	Lock adjustments securely

Symptom (Continued)	Component	Fault	Check	Remedy
8. B) Operation of S702 and S703 produces no reject action	P404	Open	Continuity with potentiometer disconnected	Replace
	V414, V415 V411, V413B	Weak or defective	Substitute new tube and check operation	Replace tube
	V401, V402, V403, V404, V405, V406	Non-conducting or low in emission	Check for presence of proper power supply voltages and substitute new tubes	Replace
	F401	Blown	Continuity through removed fuse	Replace
	T401	Defective	Measurement of input and output voltages	Replace
	CH401, CH402	Open	Continuity through windings	Replace
	RE401	Coil open	Resistance measurement from pins 1 to 8	Replace
	RE401-1, RE401-2	Contacts dirty or burned	Continuity across contacts during application of voltage to coil	Replace
	C413	Open	Resistance measurement	Replace
	R444, R425, R426, R429, R431, R442	Open	Resistance measurement	Replace resistor
	R433	Open	Pins 1 and 6 of V414 approach the +105 volt supply voltage	Replace
	R435, R405, R403, R404, R406	Open	Check for presence of proper power supply voltages at terminals	Replace

Symptom	Component	Fault	Check	Remedy
9. All containers rejected regardless of fill level	V303	Defective	Measure crystal voltage from TB400-20 to ground with and without phototube blocked. If no change check shutter operation	Replace
	RE301	Coil open	Measure crystal voltage from TB400-20 to ground with and without phototube blocked. If no change check shutter operation	Replace shutter relay assembly
	RE302	Shutter stuck open	Measure crystal voltage from TB400-20 to ground with and without phototube blocked. If no change check shutter operation	Clean or replace the shutter blade and check that the position and "throw" are correct
	Head cable	Open lead in +105 vdc supply to shutter stage	Check continuity or voltage from TB400A-15 to TB300-2	Repair or replace
	R403, R404	Open	Check continuity or voltage	Replace
	X301	Extremely noisy	Crystal voltage as measured from TB400-20 to ground varies in static condition	Replace
10. Operation erratic and unpredictable. Good containers being rejected and/or unacceptable containers being passed	Tube head assembly and conveyor system	Vibration of tube head or disturbance of fill material	Lower head one inch below normal fill level and check for stable operation	Determine and eliminate cause of vibration or disturbance
	Air valve	Sluggish	Operate unit with air solenoid turned off and light across reject contacts	Dismantle and lubricate air valve or replace

Symptom (Continued)	Component	Fault	Check	Remedy
10. Operation erratic and unpredictable. Good containers being rejected and/or unacceptable containers being passed	M102	Variations in tube current readings	See Symptom No. 6 above	
	LS501, LS502	Defective	Check output from TB500-23 to TB500-40 with recording voltmeter or with Type AP-9 meters across input and output simultaneously, observing variations	Replace defective stabilizer
	V201	Loose in its mounting	X-ray beam alignment shifts when tube head is vibrated	Re-align and secure x-ray tube in its mounting
	T201, T202	Arcing in tube head	Check for low oil level in tube head, contaminated oil in head, or breakdown of transformer insulation	Replace oil or defective component
	Terminal boards	Connections loose	Tighten all connections and check operation	Use care when reconnecting leads
	Solder joints	Faulty	Touch all suspected joints with hot soldering iron and check operation	Use care to obtain good solder joints when doing maintenance
11. Acceptable containers being rejected. Operation erratic.	Star wheels, centrifugal weighers, centrifugal filler, bulge detectors, etc.	Cause jostling of containers causing too much ripple	Lower head one inch below normal fill level and check for stable operation. Then pass containers through the conveyor system	Remove offending component from section of line near Hytafill
	V301, V409, V410, V411, V412, V415	Microphonic	Tap suspected tube with pencil. If tube is microphonic, reject action will occur	Replace

Symptoms (Continued)	Component	Fault	Check	Remedy
11. Acceptable containers being rejected. Operation erratic.	V407, V408	Microphonic	Replace suspected tube, (tapping these tubes may cause self-oscillations, resulting in rejects)	Replace
	X301, X302	Noisy	Check for variation in crystal voltage from TB400-20 to ground. Substitute new crystal	Replace
	I301 or V201	Light beam and x-ray beam out of vertical alignment	Use fluorescent probe and paper to check alignment. Vertical alignment must be within ±1/16 inch	Re-position light source, shim detector hood, or re-position x-ray tube as required
12. Underfilled containers being passed. Operation erratic.	Conveyor system	Insufficient spacing between containers	Spacing must be one-eighth inch or greater, Check operation with greater spacing than required to determine operation is normal	Increase speed of section of line approaching Hytafill or install star wheel or other spacing device



BOTTOM VIEW OF

AMPLIFIER CHASSIS

TYPE 2

NOTES

1. All voltages measured with 20,000 ohms per volt meter with amplifier disconnected. Line voltage of 115 v a-c unless otherwise specified.
2. Normal voltages may vary ± 20%. Good judgment is essential in properly interpreting voltage measurements.
3. All voltages are "d-c" unless specified as "r m s."
4. V412 and V413 will trigger when meter probe is placed on tube socket pins. Voltage on pin 2 (denoted by X) cannot be measured accurately with a 20,000 ohm per volt meter.

RESISTANCE MEASUREMENTS

VACUUM TUBE NUMBER	TUBE SOCKET PIN NUMBERS								
	1	2	3	4	5	6	7	8	9
V401	NC	115K	NC	100	NC	100	NC	115K	-
V402	72K	NC	FIL	FIL	NC	72K	100	-	-
V403	NC	GND	NC	NC	130K	NC	NC	-	-
V404	NC	GND	NC	NC	130K	NC	NC	-	-
V405	NC	130K	NC	NC	115K	NC	NC	-	-
V406	NC	66K	NC	NC	GND	NC	NC	NC	-
V407	1.25M	500	FIL	FIL	160K	230K	500	-	-
V408	280K	470	FIL	FIL	150K	220K	470	-	-
V409	450K	200K	FIL	FIL	220K	NC	20K	-	-
V410	900K	GND	FIL	FIL	220K	80K	GND	-	-
V411	130K	220K	GND	FIL	FIL	135K	230K	GND	FIL
V412	185K	430K	GND	FIL	FIL	200K	430K	GND	FIL
V413	1M	2.5M	FIL	FIL	330K	NC	430K	-	-
V414	330K	∞	82K	FIL	FIL	133K	192K	82K	FIL
V415	173K	270K	133K	FIL	FIL	220K	350K	133K	FIL

NOTE: All resistances measured to ground with electronic chassis disconnected, and potentiometer controls set fully CCW. Normal resistances may vary plus or minus 10%.

Phototube Chassis (300)

(Refer to Drawing 3591-D22)

VOLTAGE MEASUREMENTS

VACUUM TUBE NUMBER	TUBE SOCKET PIN NUMBERS								
	1	2	3	4	5	6	7	8	9
V301	+105	+0.1	+6	3.1-v a-c	3.1-v a-c	+105	+0.1	+6	3.1-v a-c
V302	+105	−10	−40	3.1-v a-c	3.1-v a-c	NC	−40	NC	3.1-v a-c
V303	+50	0	0	3.1-v a-c	3.1-v a-c	+105	−40	0	3.1-v a-c
V304	−10	−75	-	-	-	-	-	-	-

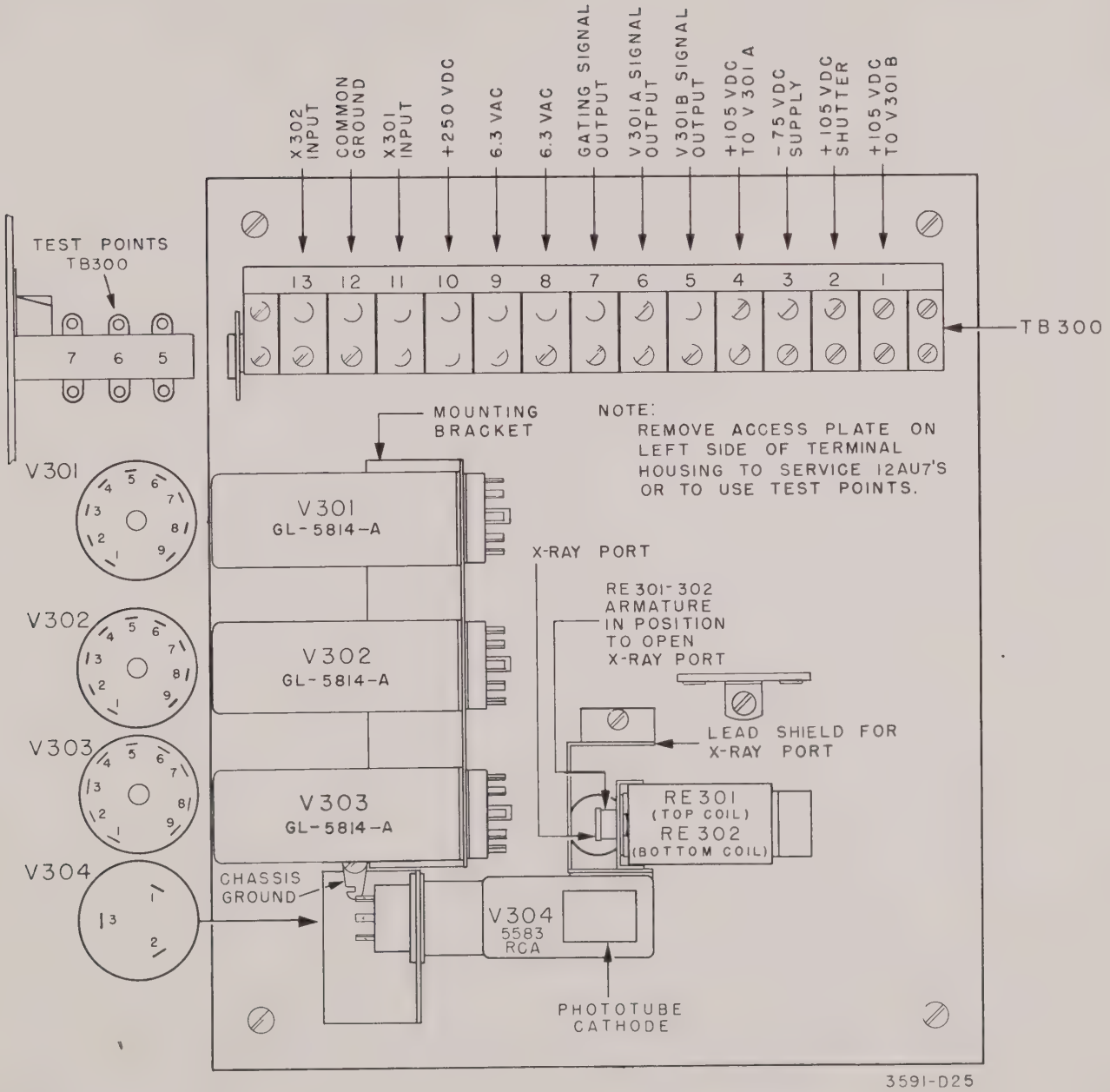
NOTES:

1. All voltages were measured with a 20,000 ohms/volt voltmeter from point shown to ground with x-ray off and light beam on phototube.
2. Voltages shown are all d-c voltages except thos labeled as v a-c.
3. Normal voltages may vary ±20%.
4. All Hytafill Units interconnected and controls set for normal operation.

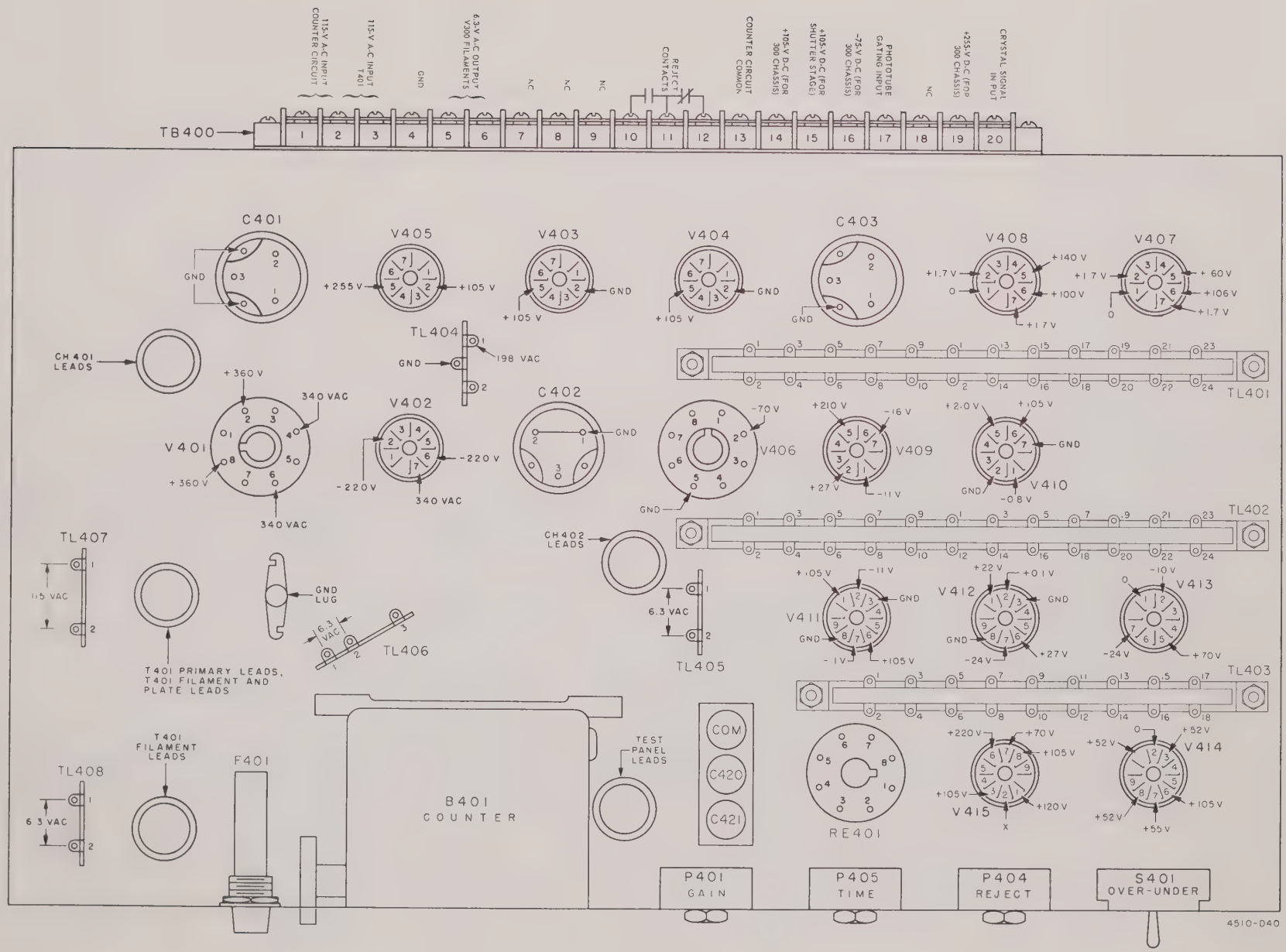
RESISTANCE MEASUREMENTS

VACUUM TUBE NUMBER	TUBE SOCKET PIN NUMBERS								
	1	2	3	4	5	6	7	8	9
V301	75K	320K	10K	0.05	0.05	75K	320K	19K	0.05
V302	75K	20M	75K	0.05	0.05	NC	NC	NC	0.05
V303	100K	500K	GND	0.05	0.05	100K	175K	GND	0.05
V304	20M	60K	500K	-	-	-	-	-	-

NOTE: All resistances measured to ground with all Hytafill Units interconnected, and RE102, filament stabilizing relay, removed from its socket. Normal resistances may vary plus or minus 10%.



PHOTOTUBE CHASSIS



NOTES

1. All voltages measured with 20,000 ohms per volt meter with amplifier disconnected. Line voltage of 115-v a-c was connected across TB400-2 and 3.
2. Normal voltages may vary ±20%. Good judgment is essential in properly interpreting voltage measurements.
3. All voltages are "d.c." unless specified as "a.c."
4. V412 and V415 will trigger when meter probe is placed on tube socket pins. Voltage on V415, pin 2 (denoted by X) cannot be measured accurately with a 20,000 ohm per volt meter

BOTTOM VIEW OF

AMPLIFIER CHASSIS

TYPE 2

RESISTANCE MEASUREMENTS

VACUUM TUBE NUMBER	TUBE SOCKET PIN NUMBERS								
	1	2	3	4	5	6	7	8	9
V401	NC	115K	NC	100	NC	100	NC	115K	-
V402	72K	NC	FIL	FIL	NC	72K	100	-	-
V403	NC	GND	NC	NC	130K	NC	NC	-	-
V404	NC	GND	NC	NC	130K	NC	NC	-	-
V405	NC	130K	NC	NC	115K	NC	NC	-	-
V406	NC	66K	NC	NC	GND	NC	NC	NC	-
V407	1.25M	500	FIL	FIL	160K	230K	500	-	-
V408	280K	470	FIL	FIL	150K	220K	470	-	-
V409	450K	200K	FIL	FIL	220K	NC	20K	-	-
V410	900K	GND	FIL	FIL	220K	80K	GND	-	-
V411	130K	220K	GND	FIL	FIL	135K	230K	GND	FIL
V412	185K	430K	GND	FIL	FIL	200K	430K	GND	FIL
V413	1M	2.5M	FIL	FIL	330K	NC	430K	-	-
V414	330K	∞	82K	FIL	FIL	133K	192K	82K	FIL
V415	173K	270K	133K	FIL	FIL	220K	350K	133K	FIL

NOTE: All resistances measured to ground with electronic chassis disconnected, and potentiometer controls set fully CCW. Normal resistances may vary plus or minus 10%.

Phototube Chassis (300)

(Refer to Drawing 3591-D22)

VOLTAGE MEASUREMENTS

VACUUM TUBE NUMBER	TUBE SOCKET PIN NUMBERS								
	1	2	3	4	5	6	7	8	9
V301	+105	+0.1	+6	3.1-v a-c	3.1-v a-c	+105	+0.1	+6	3.1-v a-c
V302	+105	−10	−40	3.1-v a-c	3.1-v a-c	NC	−40	NC	3.1-v a-c
V303	+50	0	0	3.1-v a-c	3.1-v a-c	+105	−40	0	3.1-v a-c
V304	−10	−75	-	-	-	-	-	-	-

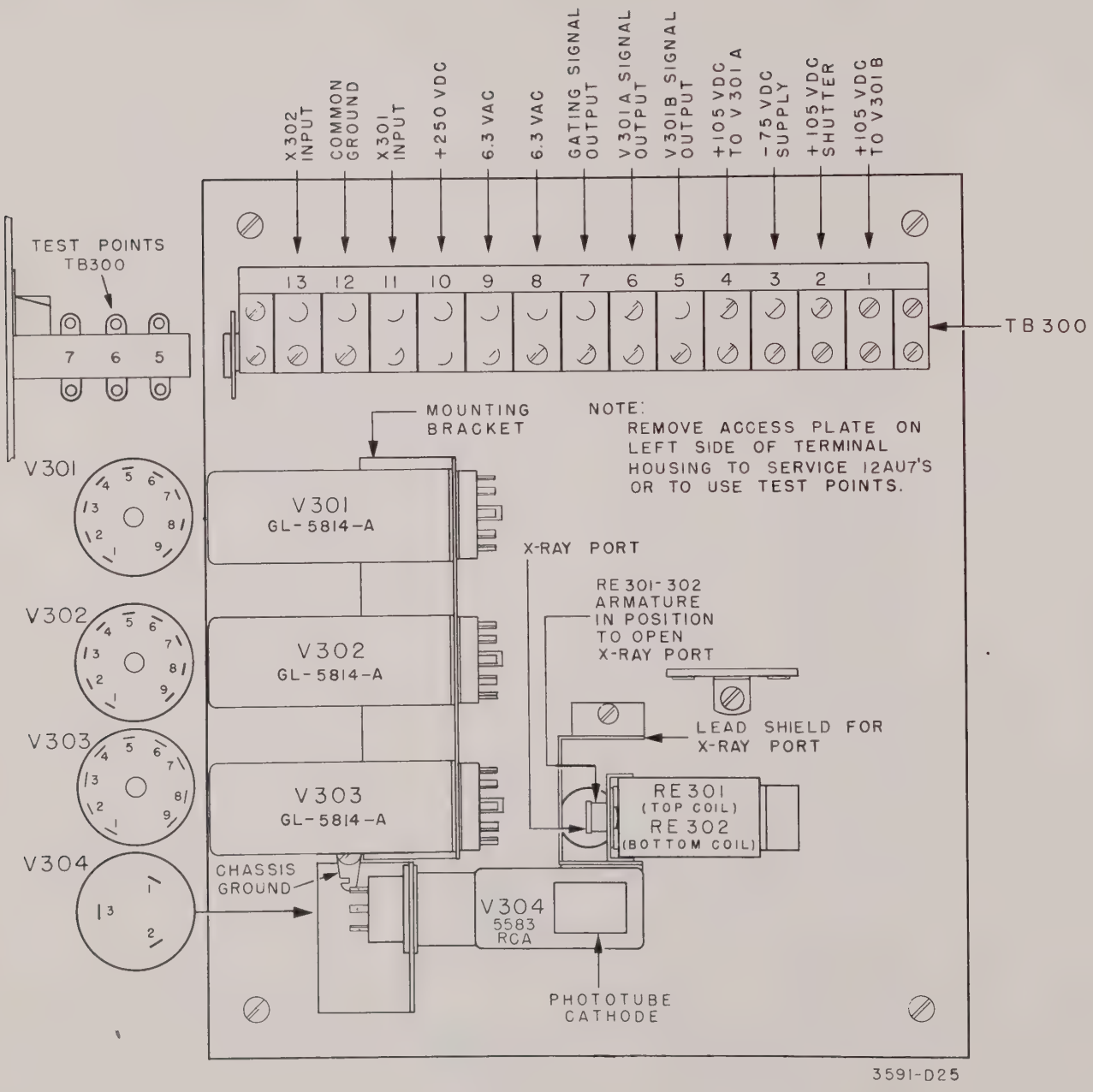
NOTES:

1. All voltages were measured with a 20,000 ohms/volt voltmeter from point shown to ground with x-ray off and light beam on phototube.
2. Voltages shown are all d-c voltages except thos labeled as v a-c.
3. Normal voltages may vary ±20%.
4. All Hytafill Units interconnected and controls set for normal operation.

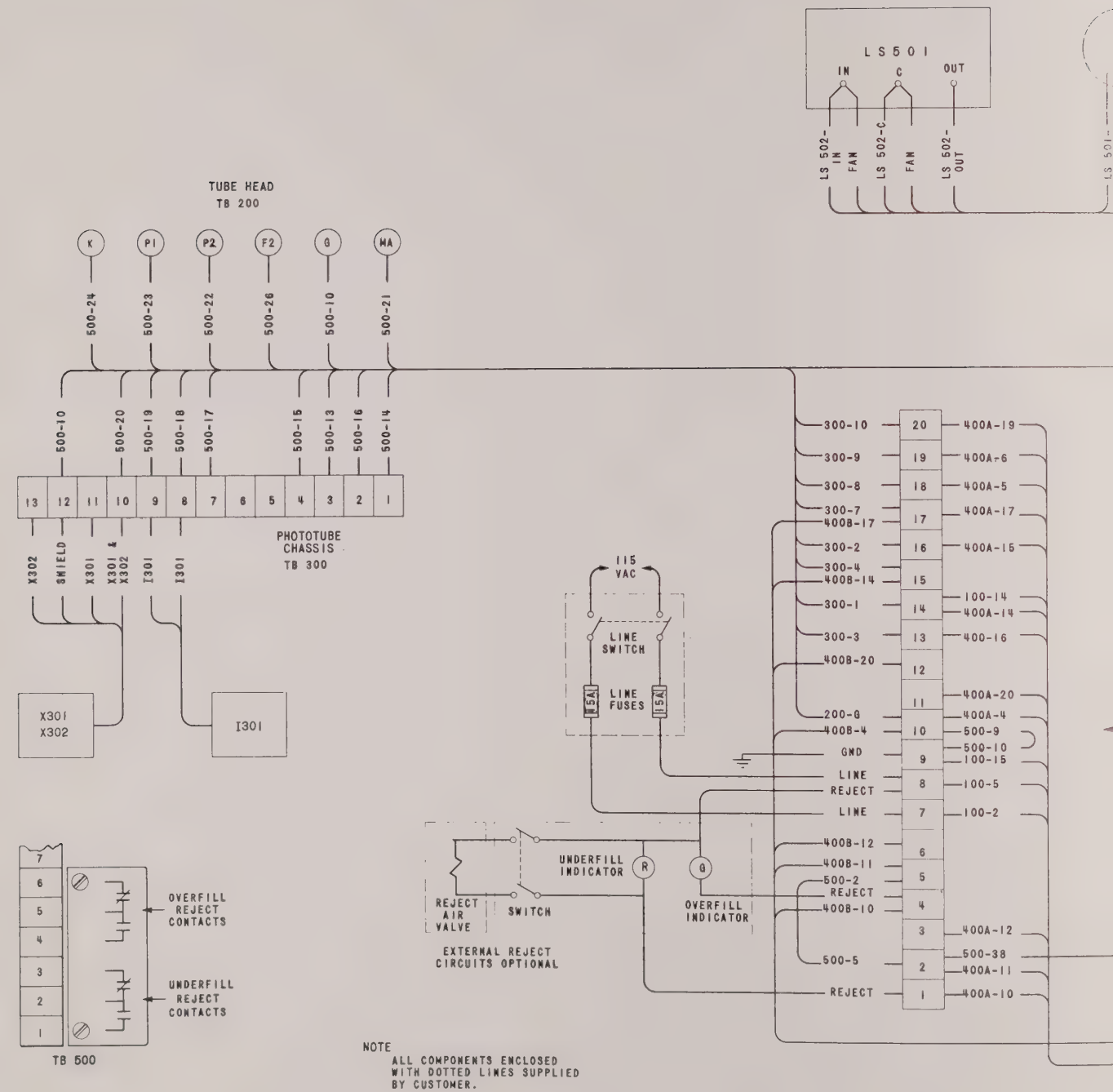
RESISTANCE MEASUREMENTS

VACUUM TUBE NUMBER	TUBE SOCKET PIN NUMBERS								
	1	2	3	4	5	6	7	8	9
V301	75K	320K	10K	0.05	0.05	75K	320K	19K	0.05
V302	75K	20M	75K	0.05	0.05	NC	NC	NC	0.05
V303	100K	500K	GND	0.05	0.05	100K	175K	GND	0.05
V304	20M	60K	500K	-	-	-	-	-	-

NOTE: All resistances measured to ground with all Hytafill Units interconnected, and RE102, filament stabilizing relay, removed from its socket. Normal resistances may vary plus or minus 10%.



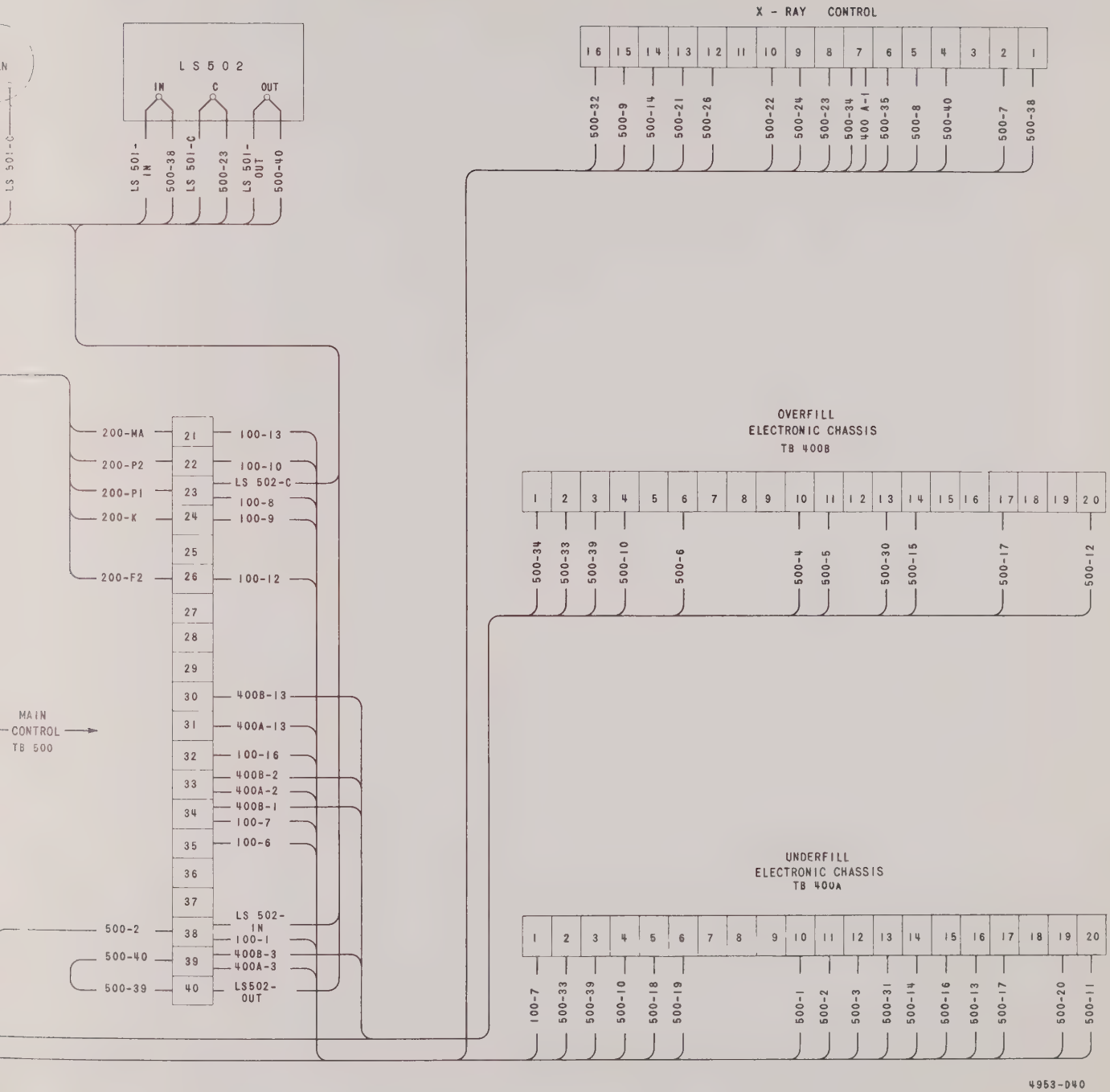
PHOTOTUBE CHASSIS



NOTE
ALL COMPONENTS ENCLOSED WITH DOTTED LINES SUPPLIED BY CUSTOMER.

INTERCONNEC

HYTAFIL



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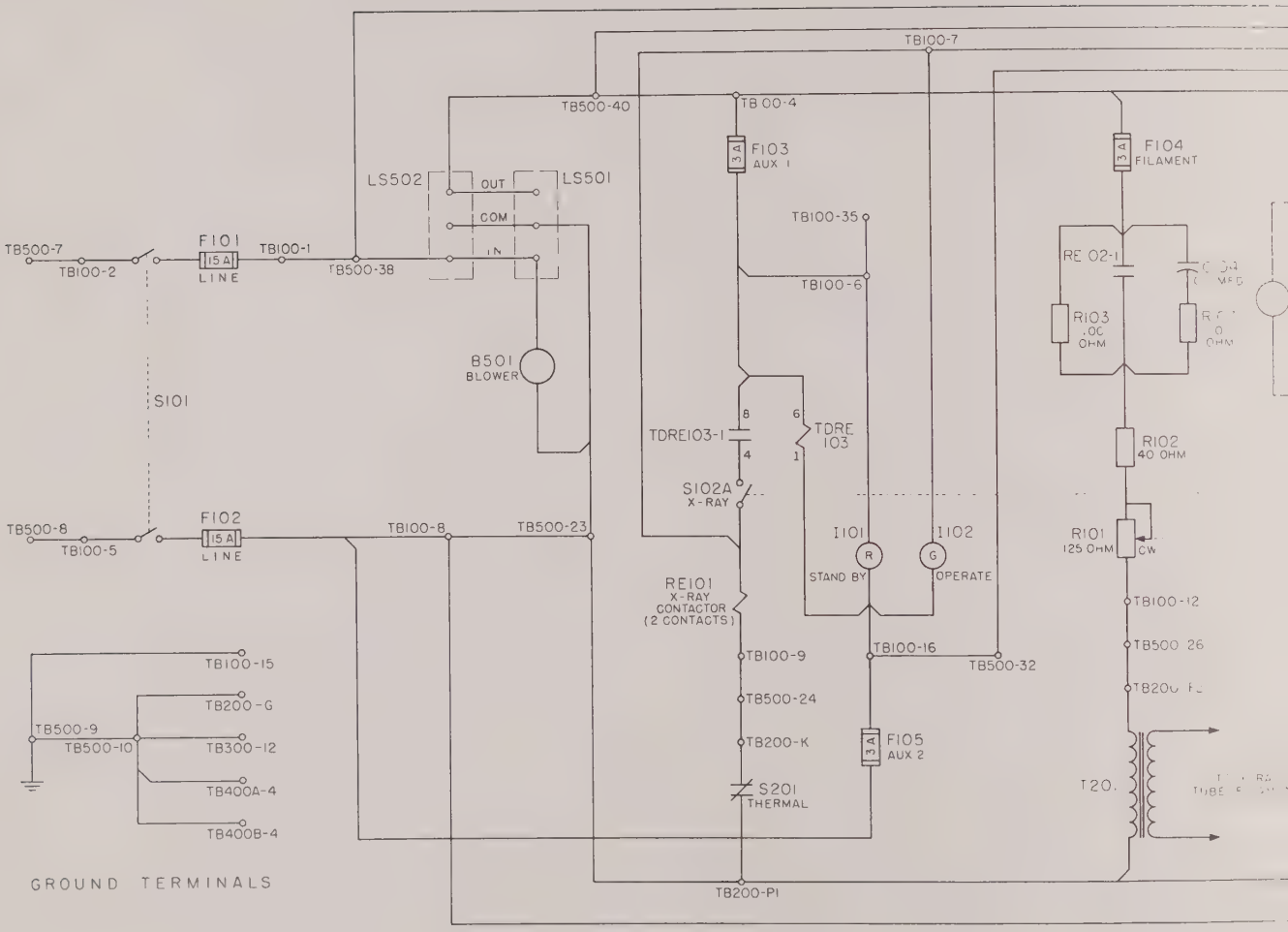
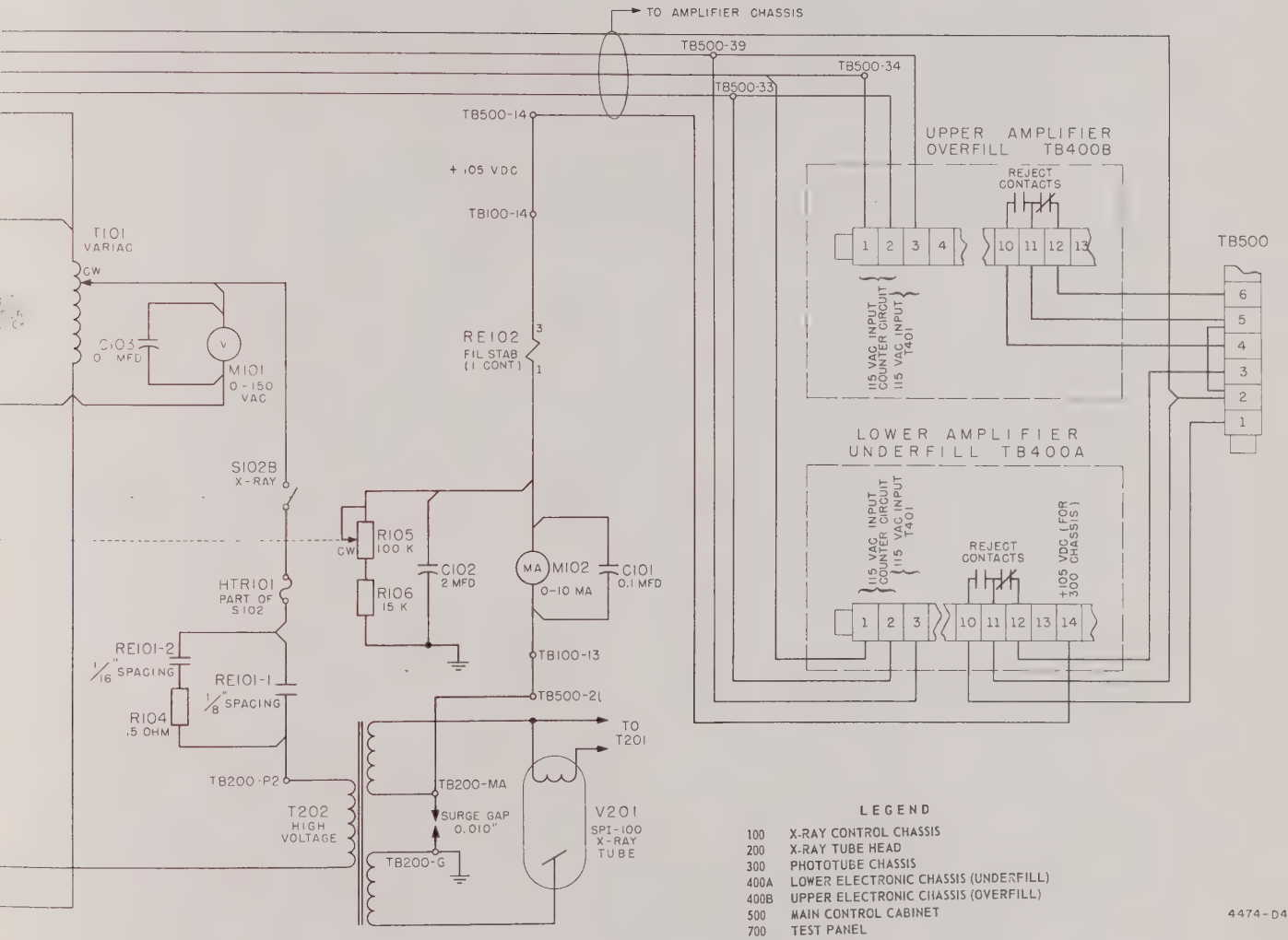
TION DIAGRAM

TYPE 2

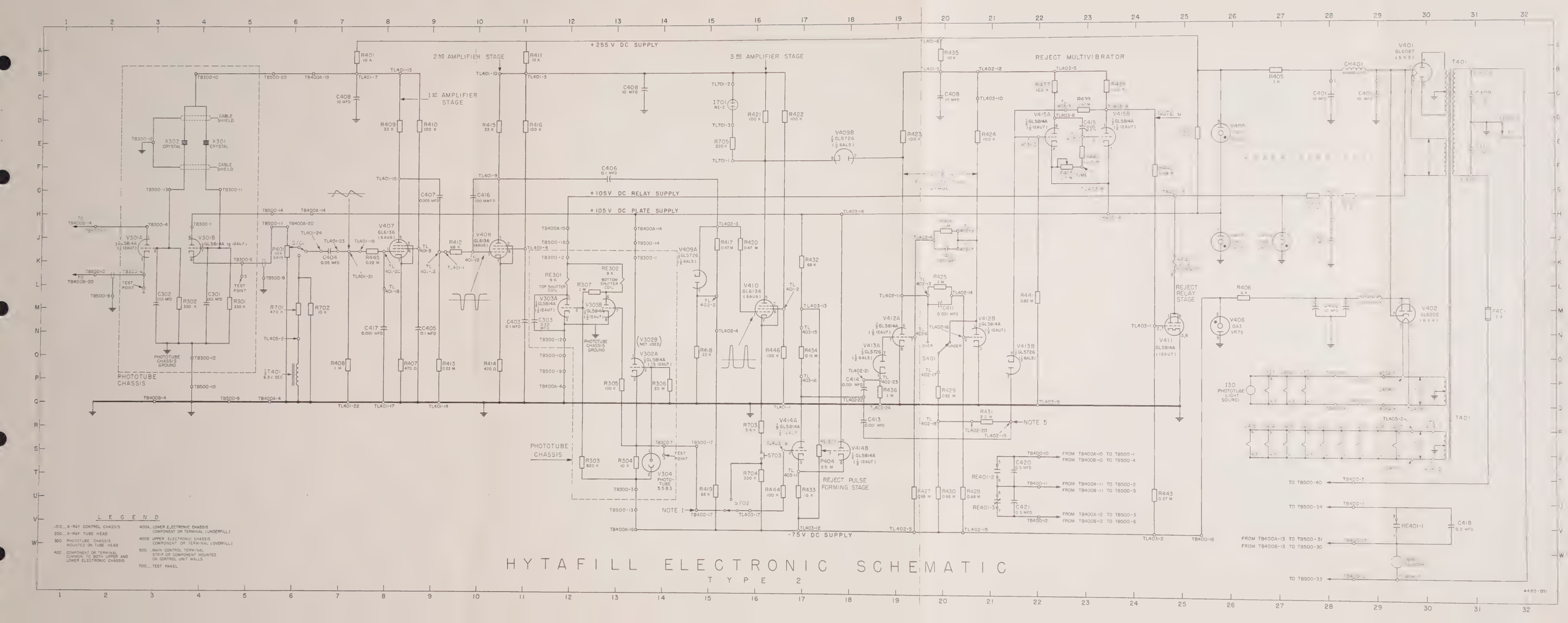


HYTAFILL X-RAY CO



R O L – E L E M E N T A R Y D I A G R A M

P E 2



HYTAFILL ELECTRONIC SCHEMATIC

TYPE 2

H Y T A F I L L

ADJUSTMENT CHECK LIST

Direction 12378

The following are the basic adjustments required for proper operation of the Hytafill for fill inspection of containers with fluids of a density approximating that of water (Beer, milk, soda pop, fruit juices and concentrates, etc.). Although in some cases they may differ from those provided in Direction 12216, Instruction Manual, they represent an abbreviation of those methods as applied to the containers indicated and are not contradictory. The methods presented herein are preferred for their simplicity, rapidity of execution, and the added reliability procured by application to the specific products indicated above.

Three conditions with respect to the normal production process are recognized: (a) Production Line Operating, Hytafill Tilted; (b) Production Line Operating, Hytafill Not Tilted, and (c) Production Line Not Operating, Hytafill Not Tilted. For the most part, the adjustments can be made with production in operation and the Hytafill not tilted at the occasional loss of inspection of the production. With practice and thorough familiarity with the adjustment procedure, however, such loss will be extremely minor and, in most cases, can be prevented by simply stopping the cans for the short intervals required.

To facilitate these adjustments, it is recommended that an indicating lamp be installed as described in Section 3.16, Direction 12216.

ADJUSTMENT NO. 1 - REJECT CONTROL ADJUSTMENT

The Reject Control may be reset or checked at any time without disturbing the settings of the other controls.

(A) All Conditions*

1. Turn line ON; X-Ray OFF; Overfill-Underfill Switch to Overfill; Reject Control fully counterclockwise (CCW).
2. Hold toggle switch S702, marked PHOTOTUBE, in the test position.
3. While slowly pressing and releasing push button S703, turn the Reject Control clockwise (CW) just until consistent reject action occurs when S703 is released.

   NOTE: If the Reject Control is turned further, reject action may appear consistent but will not occur at the proper time.
4. Lock the control at this setting and check that operation is still consistent.
5. Repeat for other chassis, if required.

ADJUSTMENT NO. 2 - GAIN CONTROL ADJUSTMENT

(A) Production Line Operating, Hytafill Not Tilted*

1. Set Gain Control fully CCW; Underfill-Overfill Switch to Underfill; Line ON; X-Ray ON.
2. Set Primary Volts at 110 and adjust Filament Control for 2 MA. Unless later changed, this is the OPERATING MA.
3. Slowly increase Gain Control (CW) up to the point where all containers are consistently rejected. Lock the control at this setting.

   If rejection cannot be obtained with maximum gain, increase MA in .5 ma steps (up to a maximum of 5 ma) performing Adjustment No. 8 after each increase, until rejection occurs. If water cooling is not used, check that the ratings are not exceeded per Direction 12216 Section 3.03.

   If still unable to obtain rejection, check Adjustment No. 1 first; then trouble-shoot the amplifier.
4. Repeat for other chassis, if required.

(B) Production Line Operating, Hytafill Tilted; or Production Line Not Operating, Hytafill Not Tilted.

   If the tube head is tilted off the conveyor, a convenient method of holding the containers in the inspection position is to fasten a piece of sheet metal, bent to form an angle, to the phototube housing cover with a "C" clamp.

1. Set Gain Control fully CCW; Underfill-Overfill Switch to Overfill; Line ON; X-Ray ON.
2. Set Primary Volts at 110 and adjust Filament Control for 2 MA. Unless later changed, this is the operating MA.
3. Insert a filled container in the inspection position

   Check that x-ray is penetrating fill material for the full diameter of the container but not through a seam.
4. Hold toggle switch S702, PHOTOTUBE, in the test position and, as rapidly as possible repeatedly press and release push button S703 to simulate containers passing through the inspection position.
5. Increase the Gain Control (CW) while actuating S703 until consistent rejection just occurs.

   If reject action cannot be obtained at maximum gain, increase MA in .5 ma steps (up to a maximum of 5 ma) until rejection occurs. If water cooling is not used, check that the ratings are not exceeded per Direction 12216 Section 3.03.

   If still unable to obtain rejection, check Adjustment No. 1 first; then trouble-shoot the amplifier.
6. Lock the control at this setting.
7. Repeat for other chassis, if required.
8. Perform Adjustment No. 3.

**The passage of production cans through the inspection position (if Hytafill is not raised) will not effect this adjustment. However, to prevent improperly timed rejections with possible line jams, shut off air or electrical power to reject air valve.*

Code 10-56

ADJUSTMENT NO. 3 - SETTING PRIMARY VOLTS

The Operating Primary Volts can be determined at any time for any setting of the Gain Control - as long as there is reasonable assurance that the Reject Control is properly adjusted. The Reject Control should not require frequent adjustment.

(A) Production Line Operating, Hytafill Not Tilted.*

1. Turn Line ON; X-Ray ON; Overfill-Underfill switch on Underfill; Set Primary Volts at 100.

   If a dual channel unit is being adjusted temporarily demobilize the amplifier not being adjusted by removing V401, first Amplifier tube.

2. Pass an empty container through the inspection position and observe that it is rejected.

3. Decrease Primary Volts just to the point that reject action becomes inconsistent. Note the value and call it X_1.

4. Increase Primary Volts to either the value at which full containers are rejected (not necessarily consistently) or 110 Primary Volts, which ever occurs first. Do NOT exceed 110 Primary Volts. Note the voltage reading call it X_2. If reject action is not obtained below or at 110 volts $X_2 = 110$.

5. Set Operating Primary Volts (X) at a value equal to 3 volts above the halfway point between X_1 and X_2.

6. Check that Operating Primary Volts (X) is at least 8 volts above X_1 and 5 volts below X_2. If not, check Adjustments No. 1 and 2 first; then trouble-shoot the amplifier.

7. If a dual channel unit is in use, repeat steps 1 through 6. For second chassis.

8. Check that the value of X for the two chassis are within 5 volts of each other and set the Operating Primary Voltage at the value obtained for the chassis used for underfill inspection.

9. Set the Overfill-Underfill Switches for the inspection required and replace V401 if previously removed.

10. Record the Operating MA and Primary Volts values on the labels below the respective meters.

(B) Production Line Not Operating, Hytafill Not Tilted; or Production Line Operating, Hytafill Tilted.

If a dual channel unit is being adjusted temporarily demobilize the amplifier not being adjusted by removing V401, First Amplifier tube.

1. Turn Line ON; X-Ray ON; Overfill-Underfill switch on Underfill; Set Primary Volts at 100.

2. Insert an empty container in the inspection position; hold S702 in the test position and simulate containers passing through the inspection position with S703.

3. Decrease Primary Volts just to the point that reject action becomes inconsistent. Note the value and call it X.

4. Insert a full container in the inspection position and again simulate containers with S702 and S703.

5. Increase Primary Volts to either the value at which the full container is rejected (not necessarily consistently) or 110 Primary Volts which ever occurs first. Do NOT exceed 110 Primary Volts. Note the voltage reading and call it X_2. If reject action is not obtained below or at 110 volts X_2=110.

6. Set Operating Primary Volts (X) at a value equal to 3 volts over the half-way point between X_1 and X_2.

7. Check that Operating Primary Volts (X) is at least 8 volts above X_1 and 5 volts below X_2. If not, check Adjustments No. 1 and 2 first; then trouble-shoot the amplifier.

8. If a dual channel unit is in use, repeat steps 1 through 7. For second chassis.

9. Check that the value of X for the two chassis are within 5 volts of each other and set the Operating Primary Voltage at the value obtained for the chassis used for underfill inspection.

10. Set the Overfill-Underfill Switches for the inspection required and replace V401 if previously removed.

ADJUSTMENT NO. 4 - ALIGNMENT; X-RAY BEAM, SHUTTER AND PORT.

This alignment procedure is normally a part of the installation process of the tube head. It should require repeating only if the complete phototube chassis is moved, if the x-ray head, tube, or shutter is replaced, or, if the lack of proper alignment is suspected because of low fluorescence or apparent misalignment when the x-ray beam is checked with the fluorescent test probe placed in between the port and the crystal housing.

CAUTION: During all testing with X-Ray ON, be careful to use the lowest Operating Volts required to clearly see the size and shape of the beam on the fluorescent test probe and to keep all parts of the body out of the direct x-ray beam. With reasonable care, all observations and adjustments can be made without the narrow direct x-ray beam striking any part of the body. In addition X-Ray should be turned on just long enough to complete a particular step.

1. X-Ray Off; Remove the hood and phototube housing cover plate (which incorporates the x-ray port).

   While you have access to this housing, check all connections, soldered joints, etc., visually to eliminate future troubles.

2. Place a 12 or 15 inch ruler across the housing and mark the center of the housing on the ruler.

   The ruler may be rested on screws partially inserted in the tapped cover mounting holes so that the x-ray beam will pass thru or just above it. (Use the distance between centers of two opposite cover screw holes as the housing "width" for this measurement.)

3. Turn X-Ray On; set MA at normal operating MA, and set Primary Volts to start at 50 volts. Increase Primary Volts as necessary to see fluorescence on probe. Do NOT exceed 110 volts.

4. With the fluorescent test probe, observe the shape of the most brilliant area on the probe.

   Both sides of this bright area should be fuzzy, and the area should be rectangular in shape with reasonably uniform density throughout.

**The passage of production cans through the inspection position (if Hytafill is not raised) will not effect this adjustment. However, to prevent improperly timed rejections with possible line jams, shut off air or electrical power to reject air valve.*

6. Recheck that the mark on the ruler is, in fact, the center of the housing (as measured between screw holes and that no error has been made in the above adjustments.) Replace the cover over the phototube and, with the fluorescent test probe, check that the most brilliant area of fluorescence is centered to the center of the housing as marked on the ruler.

If it is not, slightly loosen the four (4) mounting screws attaching the entire phototube chassis to the head. With the screw driver, pry the chassis into the proper position which centers the most brilliant area of fluorescence to the center of the housing. Tighten the chassis screws and recheck.

7. Turn x-ray OFF. Check that the center of the phototube cathode (brownish curved plate inside the phototube) is centered vertically with the x-ray port in the chassis and that the phototube is firmly held in place so that it cannot move.

If the phototube cathode is not properly centered, loosen the two screws which fasten the phototube mounting bracket to the main chassis and adjust. Re-tighten both screws firmly.

8. Clean the window in the housing cover plate, inside and out, and temporarily mount the housing cover plate and its gasket with screws. Check to see that the phototube window is centered with the phototube cathode both vertically and horizontally. Before correcting any misalignment, turn x-ray ON, and with fluorescent probe, check to see that the x-ray port is in alignment with the x-ray beam. The bright area of the fluorescent image should be nearly as bright as previously observed with the cover plate off and the side edges should still be fuzzy, the least fuzzy still being on the right side due to the shutter.

If one edge is sharp, rather than fuzzy, it is probable that the port is cutting off the beam. Inspect the cover plate to assure yourself that the port is, in fact, in the center of the cover plate (use mounting hole centers for measurement). If it is, re-perform the alignment procedure to correct the error. If it is not, correct by filing. If the window is not centered with respect to the phototube cathode, check to see that it is centered with respect to the cover plate (or housing) center. If it is, recheck above phototube alignment for error; if not, correct by carefully removeing paint from external window surface.

9. After the preceding adjustments have been properly made remount the hood and fasten it and the cover plate securely with all screws. The light and crystal detector must now be aligned per Adjustment No. 6 and 8.

ADJUSTMENT NO. 5 - ALIGNMENT; PHOTOTUBE TC X-RAY PORT AND WINDOW.

This alignment procedure is subject to the same conditions as those for Adjustment No. 4 and the preliminary paragraphs should be read before proceeding.

This procedure will normally be required only when previous adjustments are upset by moving the complete phototube chassis or phototube, replacing the x-ray head or an x-ray tube, or when low phototube signal voltage cannot be corrected by performing Adjustment No. 6 or replacing V302 through the access panel on the left side of the housing.

1. Turn Hytafill OFF. Remove hood and rest it on top of the head within reach of the light and crystal cables. Before removing the housing cover plate, use the fluorescent test probe to check that the x-ray port of the cover plate is aligned to the x-ray beam as per Adjustment No. 4, Step 8. If it is, it can be assumed that while housing cover is off, there will be no advantage to rechecking the x-ray beam alignment. If the port is not aligned to the beam go no further here. Follow Adjustment No. 4.

2. Remove the housing cover plate. While you have access to the housing, check all connections, soldered joints, etc., visually to eliminate future troubles. Perform any work (such as replace phototube, etc.) for which the unit opened up.

3. Realign phototube and reassemble as per Adjustment No. 4, Steps 7,8, and 9, making the indicated checks for x-ray beam alignment as well. Both the crystal detector and the light must then be aligned per Adjustments No. 6 and 8.

ADJUSTMENT NO. 6 - ALIGNMENT; LIGHT TO PHOTOTUBE

1. Connect a volt-ohmmeter (50 vdc scale) between ground (+) and terminal 17 (-) on the terminal strip on the back of either amplifier chassis. Use a vacuum tube voltmeter or a voltmeter with a d.c. sensitivity of 20,000 ohms per volt or better. If desired and more convenient, use Test Point 7 available through the access port in the left side of the phototube housing.

2. Turn x-ray OFF. Clean the light lens and phototube window with soft lens cleaning tissue. If lens can't be thoroughly cleaned from the outside, remove lens from housing and clean with the light lens and window thoroughly clean. Loosen slightly the four (4) screws which attach the light housing to the support bracket through the slotted holes.

3. Adjust the position of the light housing until light just covers the transparent portion of the phototube window. The light should just cover each of the four corners without over-lapping beyond the window. Read the voltmeter; it should indicate between -30 and -40 volts. Lock the housing attachment screws.

If the voltmeter reading is low or if overlapping or insufficient light coverage at the window occurs, the light must be re-focused. Loosen the cable connector at the back of the light housing and slide it and the rubber back over the cable in order to obtain access to the back of the light socket. Remove four (4) screws and slide the rear housing cover back. With a pair of long nose pliers, grasp the socket and move it back and forth to focus the light for proper size at the phototube window and even light distribution. Rotate the socket in the housing to get the long dimension of the light beam to coincide with the long dimension of the window. Watching the meter for deflection over -30 volts as well as watching the shape, light distribution, and position of the pattern will aid in getting the correct adjustment.

If, under any condition of adjustment, the voltage cannot be increased to a value between -30 and -50 volts, the light bulb or the phototube should be replaced. (Adjustment No. 5.)

Before resealing light housing, check to make certain the light socket is sufficiently tight in the housing so that it will not change position with vibration. If not locked, jam in position with a shim. Re-position rubber seal and screw on the cover, then the cable connector to make a water-tight seal.

4. Block the light to the phototube using a piece of cardboard or heavy paper. Voltmeter needle should go to the left of zero indicating a positive voltage (with the meter connections for reading negative voltage). The amount of positive voltage is unimportant.

If meter reads a negative voltage, replace V302 through the access port in left side of phototube housing. If this doesn't result in a positive voltage, there is trouble in the phototube chassis and its connections.

5. Place two cans in the inspection position. Position them so that they are spaced rim to rim (if the cans have rims) or 1/8" apart (if cans do not have rims) and so that the light beam shines through the space between the cans. The voltmeter should now read between -9 and -25 volts.

If less than -9 volts, perform the following in order named until corrected: Recheck alignment; replace tube V302 through access port; replace light bulb or phototube and realign per adjustment No. 5 and 7; trouble-shoot phototube chassis circuits; re-arrange conveyor to provide wider spacing during production runs.

6. The above completes the normal alignment procedure. If, however, erratic rejections of full cans or lack of rejections of empty cans is occurring under conditions which prove not to be due to conveyor roughness or inadequate spacing between cans, the following additional checks may be made.

Recheck the centering of the light beam with the x-ray port. With x-ray OFF and the amplifier set for overfill pass a piece of cardboard 3" wide (with clean cut edges) through the inspection position in the same direction as cans normally move. As the paper enters the light beam and shortly after it begins to uncover the phototube window the air valve and/or reject relay will operate. Make a pencil mark on the face of the head (about at the level of the x-ray port indicating the position of the paper edge at the position this occurs). Now repeat the procedure but move the card in the opposite direction. Mark the position of the left edge of the paper (on the face of the head) at the position this occurs. Now remove paper and observe marks. It is necessary that one mark appear on each side of the x-ray port. Neither mark should occur with in the port area or within vertical alignment with it (if the marks were not made at the level of the port). Although the best adjustment would be to have the marks equidistant from the center of the port, any inequality which occurs should be with the greater distance in the direction from which the cans come - as long as the other mark is no nearer than 1/8" of the right edge of the x-ray port.

To adjust, loosen the light housing mounting screws and shift the beam (as it strikes the phototube window) in the direction in which it is desired to move the marks. Re-tighten firmly the screws and recheck Step 5.

If the meter does not now read at least -9 volts, the alignment should be rechecked. If still not, replace tube V302 through access port and then, if still not, replace phototube and realign per Adjustments No. 5 and 7.

ADJUSTMENT NO. 7 - ALIGNMENT; LIGHT BEAM AND X-RAY BEAM.

Take a piece of paper and the fluorescent probe (or a piece of fluorescent screen material about 3" x 5" size) and check the vertical alignment of the light beam and x-ray beam at a position no more than 1/2" in front of the crystal housing. The center of both beams must be in alignment, vertically, within ± 1/16".

a) If they are not in alignment, adjust the light housing or teeter the hood by shimming at the phototube housing on the tube head. Misalignment may be due to distortion of the hood assembly or to shifting of the x-ray tube position within the tube head.

b) If the hood must be shimmed by more than 1/2" and the hood has not been distorted, the tube head should be opened and the x-ray tube shift corrected.

ADJUSTMENT NO. 8 - ALIGNMENT; CRYSTAL TO X-RAY BEAM

CAUTION: When X-Ray is ON during this adjustment, be careful not to position any part of the body in the narrow x-ray beam (i. e., between the crystal housing and the x-ray head).

1. Connect a testmeter (OUTPUT range, 3 va-c scale) between ground and terminal 20 on the amplifier terminal strip.

   Use a VTVM or VOM with a a.c. sensitivity of at least 1,000 ohms per volt.

   For a dual channel unit connect to the amplifier used for Underfill inspection.

   If desired and more convenient, use Test Point 5 or 6 (whichever connects to Underfill crystal) available thru the access port in the side of phototube housing.
2. Loosen the crystal positioning knobs.
3. Turn Line and X-Ray ON (use 110 Primary Volts and 2 MA).
4. Adjust the crystal positioning knob to obtain a maximum meter reading and tighten the positioning knobs.

   If no reading can be obtained check the a.c. voltage at this point. If it is not at least 5 volts replace V301. If the d c reading is normal continue with the following tests.

   If the meter reading does not increase use the fluorescent probe to center the x-ray beam on the bakelite port of the crystal housing and re-attempt to obtain alignment. If still unsuccessful, replace the crystal and again attempt alignment.

   If the new crystal cannot be aligned for a maximum reading refer to Direction 12216, Section 15.00 Trouble Shooting, step 7.
5. For a dual channel unit check the voltage at terminal 20 of the second amplifier.
6. As a final check on each crystal decrease primary volts from 110 to zero while watching the testmeter. If alignment is correct, the output voltage will decrease. If it is not correct, the output voltage will increase during a corresponding decrease of primary volts.
7. Perform Adjustments No. 2, Gain Control, and No. 3 Primary Operation Volts.

HYTAFILL

MAINTENANCE CHECK LIST

Direction No. 12379

All equipments require reasonable maintenance with use. The following checks are provided as a reference guide to the Hytafill user in keeping interruptions of production at a minimum. It is recommended that a log similar to the attached samples, be maintained on which all checks, adjustments, and stoppages are recorded for correlation of experience and the establishment of inspection intervals. The inspection intervals listed on the log sheets are recommended as a starting point only, and it is suggested that one of the line personnel be assigned the responsibility of making the 8 hour inspection.

The basic premise of these checks is to provide means of rapidly and periodically checking to detect non-apparent malfunctions and to detect gradual changes due to use, vibration, etc., sufficiently in advance of the point of interrupting production to allow most major work to be performed on the next following production free period. Some of the recommended corrections recognize that the production line may be in operation, and it is undesireable to stop this production to make permanent corrections. In those cases a temporary correction is suggested so that inspection can be maintained. However, more complete adjustments listed should be performed during the next production shut-down but within 24 operating hours.

For most effective use, this Check List should be used only for initial training of maintenance personnel and as a reference The basic checks (in large type) should be practiced on a correctly operating unit until the few steps and limits involved can be rapidly performed from memory.

The checks presented can be better performed while production is in process if the unit is operating reasonably well, if the opportunity of the normal and occasional delays (or large spacing) between groups ot cans is utilized, and if a 20 second delay of line progress is tolerable for Check #1-a- If the unit is operating very poorly, reference should be made directly to the Trouble-Shooting Procedure rather than to these Checks.

It is recommended that, as an adjunct to these checks, a pilot lamp be installed in a readily visible location and connected across the electrical feeders to the reject air valve, as described in Direction 12216, Section 3.16.

CHECK NO. 1

(a) CLEAN PHOTOTUBE WINDOW AND LIGHT LENS

using soft cleaning tissue. *(An approximately 20 second delay of can movement will be required for cleaning the phototube window).*

Shut OFF x-ray for this phase. The light lens may be cleaned while cans are in motion, but some spurious rejections may occur. A convenient method of cleaning the window and lens without scratching is with the use of a cotton tipped stick as commerically available Q-tips, etc.

(b) CHECK THAT THE PHOTOTUBE LIGHT SOURCE IS ON AND CENTERED ON THE WINDOW.

If not correct, inform the shift maintenance section.

(c) EXAMINE THE TUBE HEAD AND BELLOWS FOR OIL LEAKS.

(d) CHECK THAT COOLING WATER IS FLOWING THROUGH HEAD.

(e) 8 Hour Inspection Only:

CHECK THAT X-RAY TUBE CURRENT IS WITHIN ±0.1 MA OF THE OPERATING VALVE.

Reset if it has drifted and note on the inspection log.

If resetting is frequently required, replace stabilizing relay.

CHECK THAT PRIMARY VOLTAGE IS SET CORRECTLY

If incorrect, reset and note on the inspection log.

CHECK NO. 2

(a) EXAMINE THE 8 HOUR INSPECTION LOG.

Note any complaints and make sure they are corrected during this inspection.

(b) CHECK THE OIL LEVEL IN THE TUBE HEAD.

(c) EXAMINE THE CONTACTS ON THE MICROPOSITIONER if used. Clean the contacts by wiping with heavy paper.

If contacts are pitted, replace the relay.

(d) REMOVE THE SHUTTER BLADE (if used as a movable shutter) and examine the brass rivets.

If they are pounded flat, replace the blade; otherwise just clean the blade and coil pole faces and check positioning of the shutter.

Before replacing the cover, clean both sides of the phototube window.

(e) REMOVE THE LIGHT BULB LENS AND THOROUGHLY CLEAN.

If the tip of the bulb has a black coating or if the filament is distorted, replace the bulb.

(f) CHECK THE AIR SYSTEM LUBRICATOR AND FILTER.

CHECK NO. 3 - PHOTOTUBE OUTPUT VOLTAGE

MEASURE PHOTOTUBE OUTPUT VOLTAGE

between chassis (+) and terminal 17 (-) on either amplifier chassis with a d. c. voltmeter.

a) Light beam not interrupted.

Meter should read between (-) 20 and (-) 60 volts.

If meter reading is less than (-) 25 but over (-) 20, realign and refocus light within 24 operating hours. If less than (-) 20, realign sooner. Refer to Adjustment No. 6.

b) Light beam interrupted by container.

Meter reading with above connections should be positive (reverse reading).

If meter reading is not positive, check for excessive light reaching the phototube from nearby windows, etc. If not this, replace V302 through access port on side of tube head within 24 operating hours and repeat this check.

c) Light beam restricted by 1/8" spacing between containers.

Meter should read at least (-) 9 volts.

If meter reading is less than (-) 9 volts, realign and refocus the light within 24 operating hours. See Adjustment No. 6 first; then if still too low, Adjustment No. 5.

CHECK NO. 4 - CRYSTAL OUTPUT VOLTAGE

OBSERVE CRYSTAL OUTPUT VOLTAGE

between chassis (-) and terminal 20 (+) on each amplifier chassis with a d.c. meter.

Meter reading is relatively unimportant if operation is (or can be made to be) satisfactory under Check No. 6. Meter reading on Underfill chassis should reduce in a logical manner as each production container passes through the inspection position, returning during each large space between cans to a fairly stable valve. Readings on Overfill chassis may increase slightly or decrease depending on fill level of containers going through. In either case, meter readings with no containers going through unit may "wander" slightly.

If meter reading is very erratic or jerky (with no containers passing through), the unit may have a tendency to reject an excessive number of acceptably-filled containers. Replace crystal and realign at earliest opportunity, but in no more than 24 operating hours. Refer to Adjustment No. 6.

CHECK NO. 5 - X-RAY AND LIGHT BEAM ALIGNMENT

With a piece of paper and the fluorescent probe (or a piece of fluorescent screen material about 3" x 5" size), check the vertical alignment of the light beam and x-ray beam at a position no more than 1/2" in front of the crystal housing. The center of both beams must be in alignment, vertically, within ± 1/16" . If they are not, refer to Adjustment No. 7 or Section 9.07b Direction 12216.

CHECK NO. 6 - OPERATING PRIMARY VOLTS

CHECK OPERATING PRIMARY VOLTS ARE SUFFICIENTLY HIGH TO CLEANLY REJECT EMPTIES WITHOUT REJECTING OVERFILLED CONTAINERS.

With conveyor in operation and with or without production containers passing through the unit, pass an empty container through unit. It should be cleanly rejected. Note the Primary Voltage and call this valve "X". Now, reduce Primary Volts by 12 volts, and repass empty container through unit. It should still be cleanly rejected. If it is, increase Primary Volts slowly to 8 volts over "X", or until the unit starts to reject all containers passing through the unit (including acceptably filled containers). If 8volts over "X" can be reached before full containers are rejected, the unit can be considered to be operating satisfactorily. Reduce Primary Volts to stop rejection of full containers and set Primary Volts to "X".

If the unit will not reject an empty container at 12 volts below, or if it rejects full containers at less than 8 volts above "X", temporarily reset unit as follows:

NOTE: If the production line is not in operation perform Adjustment No. 2 and 3.

a) Set Gain Control Fully Counterclockwise.

b) Set Primary Volts at 110 volts. With Production Containers passing through the unit, adjust Gain Control just far enough clockwise to cause reject action on all containers (empty or full) going through the unit. Lower Primary Volts to stop rejections.

If such rejection of all containers cannot be obtained with the above settings, perform Adjustment No. 8.

c) Now successively reduce Primary Volts in 5 volts steps and, after each reduction, pass an empty container through the unit to see if it is rejected. (If empty containers are not rejected at 100 volts, proceed to Emergency Trouble-Shooting Procedures, (Passes all containers).

d) Temporarily set the Operating Primary Volts 3 volts above the valve halfway between 110 volts and the lowest voltage at which empty containers are rejected in the above test.

Example: Lowest voltage - 90 volts
Set Operating Primary Volts at 103 volts.

e) Record the Operating MA and Primary Volts valves on the labels on the respective meters.

Since the above setting is approximate and is for temporary use only to keep adequate inspection in process until repair can be made, within 24 hours, perform Adjustments No. 2 and 3.

CHECK NO. 7 - CONVEYOR OPERATION

INSPECT THE SECTION IN FRONT OF AND THE APPROACH TO THE HYTAFILL.

a) Check that the conveyor belts and sprockets have been cleaned and lubricated.

b) Check that the conveyor section is free of obstructions (burrs, screws, etc.).

c) Check that the conveyor rails restrict containers to single-line formation.

d) Observe that adequate spacing of containers is maintained.

e) Check that the conveyor supports and mounts are secure.

CHECK NO. 8 - PHOTOTUBE AND REJECT CIRCUITS

With conveyor operating and production containers passing through the unit, throw x-ray switch OFF. Bunch a group of containers together so the rims touch (See Note 1) by holding containers back on the conveyor. Release the containers switch Underfill-Overfill switch to Overfill, and allow 10 to 20 containers to be rejected. All containers should be cleanly rejected. Then throw the Underfill-Overfill switch to Underfill to stop rejection and turn x-ray ON to return to normal inspection.

a) If the air blasts are sharp, clean blasts, but the containers are not cleanly rejected and have a tendency to jam, the air jet and/or TIME control may need resetting.

b) If the air blasts are not sharp, clean blasts or if some blasts are longer than others, the air valve may be sluggish or the reject relay (or the condenser across its contacts) of the amplifier requires a replacement. (A pilot light across the electrical supply to the air valve solenoid will establish that the air valve is being provided with proper voltage from the amplifier reject relay and whether it is acting properly).

c) If the air blasts are sharp, clean blasts but the unit misses an occasional rejection or group of rejections, repeat test making absolutely certain that the cans do not go through the unit with less than 1/8" space between them. If condition still occurs, refer to Trouble Shooting Chart.

NOTE 1: For containers with at least a 1/16" rim. For containers with smaller or no rim, conveyor must be arranged so that containers pass through the Hytafill in-line and with no less than 1/8" between them.

CHECK NO. 9 - OPERATION

Before considering the inspection complete, operation should be observed after the production run has started to insure that all adjustments have been made and are secure.

a) With X-Ray OFF momentarily, switch to Overfill inspection and observe that all containers are cleanly rejected. Then turn x-ray back ON.

If they are not, inform maintenance section or repeat Check No. 8.

b) Pass several empty containers through the inspection position and observe that they are cleanly rejected.

If the containers are not cleanly rejected, inform maintenance section immediately or repeat Check No. 4.

c) Check that all containers pass through the inspection position undisturbed and in single-file formation.

d) Select a representative number of rejected containers and determine that operation is satisfactory.

H Y T A F I L L

EMERGENCY TROUBLE SHOOTING CHART

Direction 12377

The Emergency Trouble-Shooting Chart on the other side is arranged to provide a rapid means of checking major components or operations to facilitate localizing the trouble to a specific area. In some areas where experience has indicated a specific component as the logical suspect, that component is listed.

It is not intended that this chart be used as an all-inclusive trouble-shooting guide. It is expected that trouble will occur which cannot be localized with the chart. In these cases, reference should be made to Direction 12216, Section 15.00 Trouble Shooting.

The Emergency Trouble-Shooting Chart is intended for use with the Adjustment Check List (Direction 12378) and the Maintenance Check List (Direction 12379). The pertinent checks or adjustments for each phase of the localizing procedure are listed on the chart.

The left hand column of the chart will provide a quick reference, even for experienced personnel, to insure that a logical localization sequence is followed. If a test, as listed, indicates correct operation or meter reading, there should be no need to follow the line to the right hand column. However, each check in the left hand column presumes the tests above it have been checked and are correct. Also, the chart may in some cases reveal defects other than the one causing difficulty. In this respect it is suggested that all of the major checks in the left hand column be performed unless it is obvious that a particular defect is the cause of trouble.

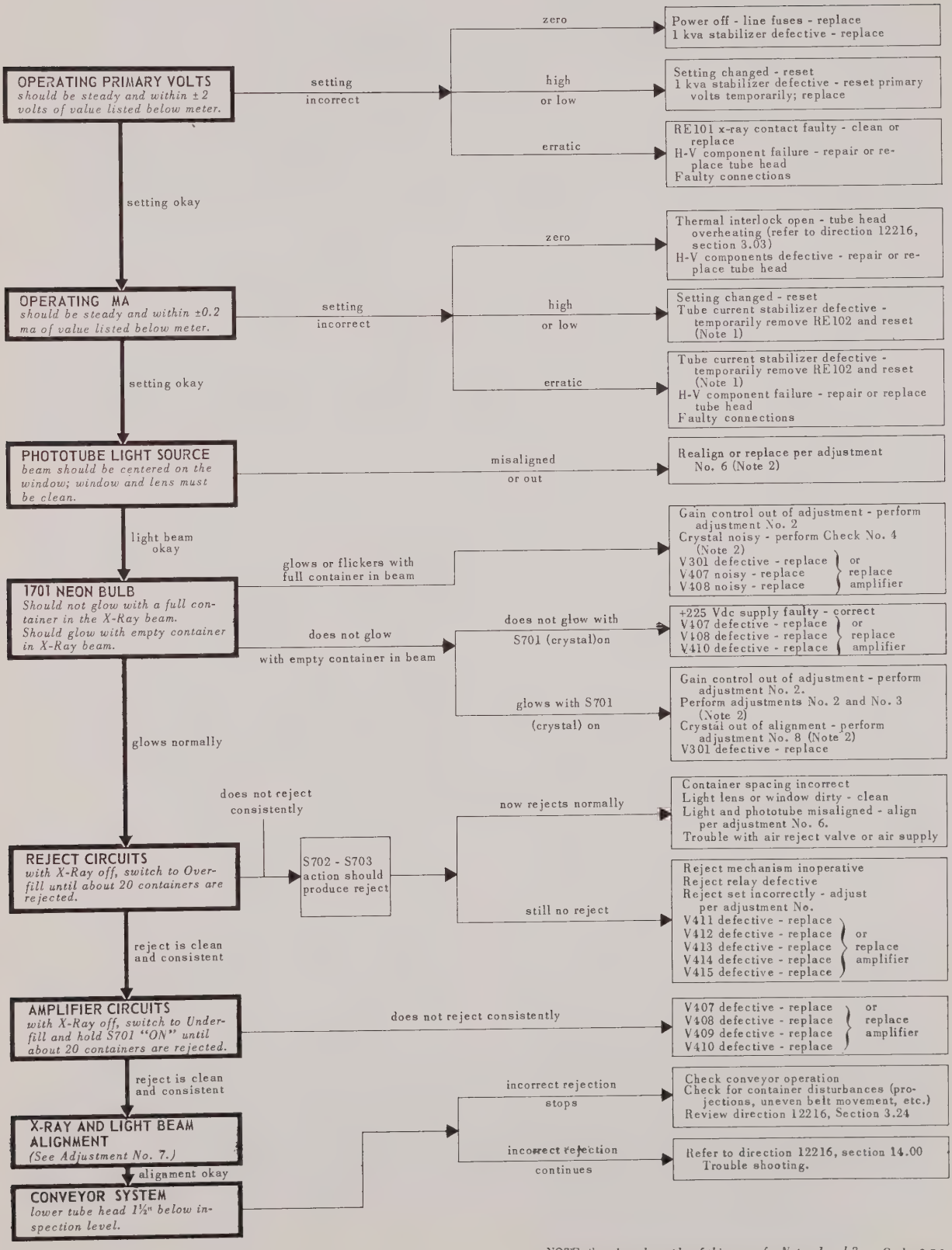
This chart has been established as a check list in the event of any malfunction rather than for a specific indication of trouble. It will be found useful for conditions of both complete and erratic malfunction; however for erratic malfunction the component breakdown or maladjustment listed may not be as clearly definite as for a complete operational failure.

NOTE 1: If tube current remains reasonably steady without the micropositioner relay RE102 should be left removed. However, the stabilizer should be repaired and a relay held available if needed for future x-ray tube change.

NOTE 2: The adjustments need not be critical at this time as long as the unit can be made to operate satisfactorily. However, they should be repeated during the next shutdown period.

HYTAFILL

EMERGENCY TROUBLE SHOOTING CHART


OPERATING PRIMARY VOLTS
should be steady and within ±2 volts of value listed below meter.
setting incorrect
zero
Power off - line fuses - replace
1 kva stabilizer defective - replace
high or low
Setting changed - reset
1 kva stabilizer defective - reset primary volts temporarily; replace
erratic
RE101 x-ray contact faulty - clean or replace
H-V component failure - repair or replace tube head
Faulty connections
setting okay
OPERATING MA
should be steady and within ±0.2 ma of value listed below meter.
setting incorrect
zero
Thermal interlock open - tube head overheating (refer to direction 12216, section 3.03)
H-V components defective - repair or replace tube head
high or low
Setting changed - reset
Tube current stabilizer defective - temporarily remove RE102 and reset (Note 1)
erratic
Tube current stabilizer defective - temporarily remove RE102 and reset (Note 1)
H-V component failure - repair or replace tube head
Faulty connections
setting okay
PHOTOTUBE LIGHT SOURCE
beam should be centered on the window; window and lens must be clean.
misaligned or out
Realign or replace per adjustment No. 6 (Note 2)
light beam okay
1701 NEON BULB
Should not glow with a full container in the X-Ray beam.
Should glow with empty container in X-Ray beam.
glows or flickers with full container in beam
Gain control out of adjustment - perform adjustment No. 2
Crystal noisy - perform Check No. 4 (Note 2)
V301 defective - replace
V407 noisy - replace
V408 noisy - replace
or replace amplifier
does not glow with empty container in beam
does not glow with S701 (crystal) on
+225 Vdc supply faulty - correct
V407 defective - replace
V408 defective - replace
V410 defective - replace
or replace amplifier
glows with S701 (crystal) on
Gain control out of adjustment - perform adjustment No. 2.
Perform adjustments No. 2 and No. 3 (Note 2)
Crystal out of alignment - perform adjustment No. 8 (Note 2)
V301 defective - replace
glows normally
does not reject consistently
REJECT CIRCUITS
with X-Ray off, switch to Overfill until about 20 containers are rejected.
S702 - S703 action should produce reject
now rejects normally
Container spacing incorrect
Light lens or window dirty - clean
Light and phototube misaligned - align per adjustment No. 6.
Trouble with air reject valve or air supply
still no reject
Reject mechanism inoperative
Reject relay defective
Reject set incorrectly - adjust per adjustment No.
V411 defective - replace
V412 defective - replace
V413 defective - replace
V414 defective - replace
V415 defective - replace
or replace amplifier
reject is clean and consistent
AMPLIFIER CIRCUITS
with X-Ray off, switch to Underfill and hold S701 "ON" until about 20 containers are rejected.
does not reject consistently
V407 defective - replace
V408 defective - replace
V409 defective - replace
V410 defective - replace
or replace amplifier
reject is clean and consistent
X-RAY AND LIGHT BEAM ALIGNMENT
(See Adjustment No. 7.)
alignment okay
CONVEYOR SYSTEM
lower tube head 1½" below inspection level.
incorrect rejection stops
Check conveyor operation
Check for container disturbances (projections, uneven belt movement, etc.)
Review direction 12216, Section 3.24
incorrect rejection continues
Refer to direction 12216, section 14.00 Trouble shooting.

NOTE: *See the other side of this page for Notes 1 and 2.*

Production Line Number 6

Unit Number 3B

For Use with Dir. 12378 and 12379.

HYTAFILL
PERIODIC INSPECTION LOG
SHEET A
Direction 12395

TO BE PERFORMED BY LINE PERSONNEL

8 hour Inspection

Date	Hr. Clock Reading	Check No. #1	Check No. #9	Done By	Troubles Noted
2-10-56	14600	✓	✓	PH	
2-10-56	14608	✓	✓	PH	
2-11	14616	✓	✓	PH	small oil leak on tube head
2-11	14624	✓	✓	PH	
2-12	14632	✓	✓	PH	
2-12	14640	✓	✓	PH	
2-13	14656	✓	✓	PH	conveyor belt getting rough
2-14	14664	✓	✓	PH	
2-14	14672	✓	✓	PH	
2-15	14680	✓	✓	PH	
2-15	14688	✓	✓	PH	x-ray tube current is drifting
2-17	14704	✓	✓	PH	
2-18	14712	✓	✓	PH	
2-18	14720	✓	✓	PH	
2-19	14728	✓	✓	PH	

SAMPLE

Production Line Number 6

Unit Number 3B

For Use with Dir. 12378 and 12379

HYTAFILL
PERIODIC INSPECTION LOG
SHEET B
Direction 12396

48 Hour Inspection

TO BE PERFORMED BY LINE OR MAINTENANCE PERSONNEL

Date	Hr. Clock Reading	Check No. (Refer to Check List) #1	#6	#8	#9	Done By	Troubles Noted
12-18	14648	✓	✓	✓	✓	PH	
12-17	14696	✓	✓	✓	✓	PH	x-ray tube current lifting – replaced micropositioner relay
12-24	14792	✓	✓	✓	✓	PH	
12-29	14840	✓	✓	✓	✓	PH	

SAMPLE

Production Line Number 6

Unit Number 3B

For Use with Dir. 12378 and 12379

HYTAFILL
PERIODIC INSPECTION LOG
SHEET C
Direction 12397

144 Hour Inspection

TO BE PERFORMED BY MAINTENANCE PERSONNEL

Date	Hr. Clock Reading	Check No. (see Check List) #1	#2	#3	#4	#5	Adjustment No. #1	#2	#3	Check No. #7	#8	#9	Done By	Troubles Noted
12-21	14744	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	PH	replaced phototube
1-3-57	14888	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	PH	
1-14	15032	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	PH	conveyor corner support is loose

SAMPLE

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